UNIVERSITATEA DIN BUCUREŞTI

Facultatea de Fizică

Programul de studii universitare de licenţă	**FIZICĂ (în limba engleză) - PHYSICS**
Domeniul de studii de licență	**FIZICĂ**
Durata studiilor	**3 ANI/180 credite (ECTS)**
Forma de învăţământ:	**Învățământ cu frecvenţă (IF)**

Fișele disciplinelor din planul de învățământ

Compulsory courses

DI.101F.EN Real Analysis

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma, and Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Real Analysis
2.2. Teacher	Prof. dr. Claudia Timofte
2.3. Tutorials/Practicals instructor(s)	Prof. dr. Claudia Timofte

2.4. Year of study	I	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	6	distribution:	Lectures	3	Tutorials	3	Practicals	0	Project	0
3.2. Total hours per semester	84	distribution:	Lectures	42	Tutorials	42	Practicals	0	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	22
3.3.2. Research in library, study of electronic resources, field research	20
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	62
3.5. Total hours per semester	150
3.6. ECTS	6

4. Prerequisites (if necessary)

4.1. curriculum	High school mathematics courses: Algebra, Mathematical Analysis.
4.2. competencies	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia room (with video projector). Lecture notes. Recommended bibliography.
5.2. for practicals/tutorials/projects	Video projector. Computers.

6. Specific competences acquired

Professional competencies	▪ The identification and the appropriate use of the main physical laws and principles in a given context. ▪ The use of suitable software packages for data analysis and processing. ▪ Solving Physics problems under given conditions using analytical, numerical, and statistical methods.
Transversal competencies	▪ The efficient use of the information sources and of the communication and professional development resources in Romanian and in a widely used foreign language, as well. ▪ Carrying out professional tasks efficiently and responsibly, in compliance with the field-specific legislation, ethics, and deontology, under qualified assistance.

7. Course objectives

7.1. General objective	▪ Knowledge, understanding, and appropriate use of the fundamental concepts of differential, integral, and vector calculus for real functions of several variables, with applications in Physics. ▪ Achieving a deep theoretical understanding of the basic concepts of Real Analysis. ▪ Acquiring a solid mathematical basis for understanding and modeling complex processes and phenomena in the field of Physics. Possibility of applying differential and integral calculus knowledge in the study of other disciplines. ▪ Acquisition of computational skills.

7.2. Specific objectives	▪ Knowledge and proper use of notions specific to Real Analysis: convergence, series, limit, continuity, and derivability for real functions of several variables, applications of differential calculus in optimization and approximation theory, differential operators, line integrals, multiple integrals, surface integrals and integral formulas, applications of integral calculus in Physics. ▪ Development of intuition and of logical and abstract thinking. Gaining the ability to work in a team. Computing skills development.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Metric spaces. Normed spaces. Spaces with scalar product. Real Euclidean spaces.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	2 hours
Sequences in R^n. Convergent and fundamental sequences. Complete spaces. Series in normed spaces. Number series. Convergence tests.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	3 hours
Limits of functions. Continuous functions. Continuous functions on compact sets. Uniform continuity. Connected sets.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	3 hours
Differentiable functions on R^n. Partial derivatives. Jacobi matrix. Differential operators: gradient, divergence, curl. Applications in physics.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	6 hours
Higher order differentials. Taylor's formula. Local extrema. Implicit functions and systems of implicit functions.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	4 hours
Sequences and series of functions. Pointwise and uniform convergence. Power series. Taylor series. Fourier series. Applications.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	6 hours
Integrable functions. Improper integrals. Parameter-dependent integrals. Improper integrals depending on parameters. Euler's functions.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	3 hours
Line integrals. Paths. Line integrals of the first kind. Integration of differential forms of degree one.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	3 hours
Multiple integrals. Change of variables in multiple integrals. Improper multiple integrals. Applications.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	4 hours
Area of a smooth surface. Surface integrals. Oriented surfaces. Flux of a field through a surface.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	4 hours
Integral formulas: Green-Riemann, Gauss-Ostrogradski, Stokes. Mechanical work. Path-independence of line integrals. Applications in physics.	Systematic exposition. Interactive lecture. Critical analysis. Examplification.	4 hours

Bibliography:

▪ G. Arfken, H. Weber, "Mathematical Methods for Physicists", Elsevier Academic Press, 2005.
▪ P. Bamberg, S. Sternberg, "A Course in Mathematics for Students of Physics", Cambridge University Press, 1990.
▪ N. Cotfas, L. Cotfas, "Elements of Mathematical Analysis" (in Romanian), Editura Universității din București, 2010.
▪ R. Courant, "Differential and Integral Calculus", Wiley, New York, 1992.
▪ A. Halanay, V. Olariu, S. Turbatu, "Mathematical Analysis" (in Romanian), Editura Didactică și Pedagogică, 1983.
▪ E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2011.
▪ K. F. Riley, M. P. Hobson, S. J. Bence, "Mathematical Methods for Physics and Engineering", 3rd edition, Cambridge University Press, Cambridge, 2006.

▪ W. Rudin, "Principles of Mathematical Analysis", McGraw-Hill, New York, 1964. ▪ C. Timofte, ”Differential Calculus”, Editura Universității din București, 2009. ▪ C. Timofte, "Real Analysis", lecture notes, 2021.

8.2. Tutorials	Teaching and learning techniques	Observations
The seminar follows the course content. The issues to be discussed are meant to provide the student with a deep understanding of the theoretical concepts presented during the lectures, to develop computing skills and the appropriate use of the basic concepts of real analysis.	Exposition. The exercise. Problematization. Guided work. Team work. Solving individual tasks.	42 hours
Bibliography: ▪ L. Aramă, T. Morozan, "Problems of Differential and Integral Calculus" (in Romanian), Editura Tehnică, Bucureşti, 1978. • F. Ayres Jr., E. Mendelson, ”Schaum's Outline of Calculus", fourth edition (Schaum's Outline Series), McGraw-Hill, New York, 1999. • Gh. Bucur, E. Câmpu, S. Găină, "Problems of Differential and Integral Calculus" (in Romanian), vol. I - III, Editura Tehnică, Bucureşti, 1978. ▪ B. Demidovich, "Problems in Mathematical Analysis", Mir Publishers, Moscow, 1977. ▪ N. Donciu, D. Flondor, "Mathematical Analysis. Problems" (in Romanian), Editura ALL, 1998. ▪ D. Flondor, O. Stanasila, "Lessons of Mathematical Analysis and Solved Exercises" (in Romanian), Editura ALL, 1996. ▪ Gh. Procopiuc, M. Ispas, "Problems of Mathematical Analysis" (in Romanian), Iasi, 2002.		

8.3. Practicals	Teaching and learning techniques	Observations
Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 competences and abilities, which are important for an undergraduate student in the field of modern Physics, corresponding to national and international standards. The contents and the teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or from the European Union. The contents are in line with the requirements of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment Methods	10.3. Weight in final mark
10.4. Lecture	▪ Clarity, coherence, and conciseness of the exam presentation. ▪ Knowledge and understanding of the fundamental concepts of Real Analysis. ▪ Correct use of mathematical methods and techniques. ▪ The ability to demonstrate/justify theoretical results and to analyze specific examples.	Written and oral examination (online or "face-to-face"). For online assessment, the exam questions will be sent electronically, via e-mail or via Google Meet or Microsoft Teams platforms. The exam will be recorded and, throughout whole its duration, the students will have their video cameras turned on.	80%
10.5.1. Tutorial	▪ The ability to apply specific results obtained in this course to solve given problems.	Homework assignments. Individual or team projects. Active classroom participation.	20%

	▪ The ability to solve practical problems specific to the course and to correctly interpret, analyze, and present the obtained results.		
10.5.2. Practical			
10.5.3. Project			

10.6. Minimal requirements for passing the exam

▪ Adequate knowledge and application of the fundamental notions of Real Analysis: convergence, series, limit, continuity, derivability, and integrability for real functions of several variables.

Requirements for getting mark 5 (10 points scale)

- Students must attend at least 50% of the lecture hours and at least 75% of the tutorial ones.
- Fulfillment of at least 50% of each of the criteria that determine the final grade.

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	Tutorials instructor name and signature
5.11.2021	Prof. dr. Claudia Timofte	Prof. dr. Claudia Timofte

Date of approval
11.11.2021

Head of Department
Lect. dr. Roxana Zus

DI 102F.EN Algebra, Geometry and Differential Equations

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	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Algebra, Geometry and Differential Equations							
2.2. Teacher				Conf. Dr. Radu Slobodeanu				
2.3. Tutorials instructor(s)				Conf. Dr. Radu Slobodeanu				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1]	DC
							Type [2]	DI

1) fundamental (DF), specialty (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours / week in curriculum	6	distribution:	Lectures	3	Tutorials	3	Practical	-	Project	-
3.2. Total hours / semester	84	distribution:	Lectures	42	Tutorials	42	Practical	-	Project	-
3.3 Distribution of estimated time for study										Hours

3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	24
3.3.2. Research in library, study of electronic resources, field research	14
3.3.3. Preparation for tutorials/projects/reports/homeworks	24
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	62
3.5. Total hours per semester	150
3.6. ECTS	6

4. Prerequisites (if necessary)

4.1. curriculum	High school mathematics
4.2. competencies	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Classroom with video projector. Access to the library and to internet resources (Moodle or Google Classroom)
5.2. for tutorials/projects	Classroom with video projector. Mathematica software.

6. Specific competences acquired

Professional competencies	- Solving physics problems using analytical, numerical and statistical methods - communication and analysis of information from Physics, with didactic purpose or for research and popularization. -cross-disciplinary approach of some topics in the area of Physics.
Transversal Competencies	Efficient use of informational sources and of professional training and dissemination resources in a language of international circulation.

7. Course objectives

7.1. General objective	Understanding the linear algebraic structures appearing in physical models (especially in quantum mechanics) and developing related mathematical problem-solving skills (also using software Mathematica).
7.2. Specific objectives	Knowledge, understanding and appropriate use of the specific notions of linear algebra, curves and surfaces geometry and of the techniques for solving some ordinary differential equations.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
VECTOR SPACES. Linear independence. Subspaces. The span of a set of vectors. Basis and dimension of a vector space.	Lecturing. Demonstrating (Examples). Classroom discussions.	6h
The change of basis matrix. The change of coordinates of a vector at the change of basis. Sums and intersections of subspaces. Direct sums of subspaces. Complements of a subspace. Factor spaces. Lines, planes, hyperplanes**.**	Idem	6h
MATRICES. Linear maps (linear transformations). The image (range) and the kernel of a linear map. Isomorphism of vector spaces. The matrix associated to a linear map with respect to a pair of bases. Operations with matrices. The change of associated matrix at the change of bases. The algebra of matrices.	Idem	6h
LINEAR SYSTEMS. Gauss-Jordan elimination for finding the rank or the inverse of a matrix. Determinants. Solving linear systems.	Idem	3h
EUCLIDEAN SPACES. Inner product. Orthogonality. Orthogonal bases, orthonormal bases. The Gram-Schmidt orthogonalization method. The orthogonal complement of a subspace. Description of quantum system through finite dimensional Hilbert spaces.	Idem	3h

COMPLEMENTS OF VECTOR CALCULUS. Cross product. Mixed product. Applications to physics. TENSOR PRODUCT. Linear forms and bilinear forms . The dual space. The bidual space. The dual basis and the canonical isomorphism. Multilinear maps and multilinear forms. Tensors. Operations with tensors. The change of coordinates of a tensor at a change of basis.	Idem	6h
MATRIX STRUCTURE. Eigenvalues and eigenvectors. The characteristic polynomial. Invariant subspaces. The structure of linear operators. Diagonalisation. The adjoint of a linear operator. Self-adjoint operators. Orthogonal and unitary operators.	Idem	3h
QUADRATIC FORMS. The Law of Inertia. The reduced (diagonal) form of a quadratic form.	Idem	3h
APPLICATIONS IN GEOMETRY. Affine spaces and transformations. Affine subspaces. Affine frames. Conics and quadrics. The reduced canonical equation. The classification of conics and quadrics.	Idem	3h
DIFFERENTIAL EQUATIONS. Ordinary differential equations: of first order, of higher order, linear, with constant coefficients. Variation of constants method.	Idem	3h
Bibliography: V. Barbu, *Ecuații diferențiale*, Ed. Junimea, 1985. N. Cotfas, *Elemente de algebră liniară* , Ed. Univ. București, 2009. A. Givental, *Linear Algebra and Differential Equations,* Berkeley Mathematics Lecture Notes, vol. 11, AMS, 2001. A. I. Kostrikin, Yu. I. Manin, *Linear Algebra and Geometry,* Gordon and Breach Science Publishers, 1989. S. Lang, *Linear Algebra,* Springer, 2007. E. B. Vinberg, *A Course in Algebra,* Graduate studies in Mathematics, vol. 56, AMS, 2003.		
8.2. Tutorials	Teaching and learning techniques	Observations
The seminar follows the course content. The issues to be discussed are meant to provide the student with a deep understanding of the theoretical concepts presented during the course, to develop computing skills and the appropriate use of the basic concepts of linear algebra, geometry and ordinary differential equations presented in lectures.	Exercises and problem solving. Guided work	42h
Bibliography: G. Arfken, H. Weber, F.E. Harris, *Mathematical Methods for Physicists*, 7th edition, Elsevier 2011. D. Blideanu, I. Popescu, D. Ștefănescu, *Probleme de algebră liniară*, Ed. Univ. București, 1986. S. Lipschutz, Lipson, M. *Linear algebra*, Schaum's outline, McGraw-Hill Education, 2018. P.J. Olver, C. Shakiban, *Applied Linear Algebra*, 2nd edition, Springer 2018. D. Ștefănescu, *Modele matematice in fizică*, Ed. Univ. București 1984.		
8.3. Practicals	Teaching and learning techniques	Observations
-	-	-
Bibliography: -		
8.4. Project	Teaching and learning techniques	Observations
-	-	-
Bibliography: -		

9. 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 competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to international standards. 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 directly useful in the future professional activity of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - ability to apply theoretical results and the standard techniques related to (Euclidean) vector (sub)spaces, linear operators (eigenvalues, eigenvectors), quadratic forms and linear constant coefficients differential equations - ability to analyse specific examples	written exam (alternatively: two partial evaluations)	80%
10.5.1. Tutorial	Correct identification and application of the method needed for problem solving	Homeworks	20%
10.5.2. Practical	-	-	-
10.5.3. Project	-	-	-
10.6. Minimal requirements for passing the exam At least 50% of points at the exam and 50% of due homeworks. Being present at minimum 50% of the tutorials Requirements for getting mark 5 (10 points scale) • Students must attend at least 50% of the lecture hours and at least 75% of the tutorial ones. • Fulfillment of at least 50% of each of the criteria that determine the final grade. 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 5.11.2021	Teacher's name and signature Radu Slobodeanu	Practicals/Tutorials instructor(s) name(s) and signature(s)

Date of approval
11.11.2021

Head of Department
Lect.dr. Roxana ZUS

DI.103F.EN Classical Mechanics I

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Structure of the Matter, Earth and Atmospheric Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Classical Mechanics I							
2.2. Teacher				Associate Professor Cătălin Berlic Associate Professor Cheche Tiberius Ovidius				
2.3. Tutorials/Practicals instructor(s)				Associate Professor Cătălin Berlic Associate Professor Cheche Tiberius Ovidius				
2.4. Year of study	I	2.5. Semester	1	2.6. Type of	E	2.7.	Content [1)]	DF

				evaluation		Classification of course unit	Type 2)	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	-	Practicals	2	Project	-
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	-	Practicals	28	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	6
3.3.3. Preparation for practical/tutorials/projects/reports/homework	14
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Is not the case
4.2. competencies	Good level of understanding of algebraic calculus, elements of geometry, trigonometry and mathematical analysis. General physics knowledge.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia room (computer, video projector and projection screen)
5.2. for practicals/tutorials/projects	Laboratory with the necessary equipment for carrying out practical works. Computers, Video projector, software packages for data analysis and processing.

6. Specific competences acquired

Professional competencies	Identification and proper use of the main laws, notions and principles specific to mechanics. Solving classical mechanics exercises under imposed conditions. Carrying out mechanical experiments using standard laboratory equipment and evaluating the results based on theoretical models. Creative application of the knowledge acquired in order to understand and model the processes specific to classical mechanics. Communication and analysis of scientific information in the field of physics. Use of specific software packages for data analysis and processing.
Transversal competencies	Efficient use of information sources and communication and training resources. Carrying out professional tasks efficiently and responsibly in compliance with the legislation, ethics and deontology specific to the field, under qualified assistance. Applying efficient teamwork techniques on various hierarchical levels.

7. Course objectives

7.1. General objective	Assimilation of concepts and laws specific to classical mechanics, development of students' ability to perform and interpret experimental works and problem solving specific to classical mechanics.
7.2. Specific objectives	- Analysis and modeling of mechanical movement; - Applied study from simple to complex following the specific conservation laws; - Applying the theoretical concepts in solving the problems of classical mechanics, as well as formulating rigorous and reasoned theoretical conclusions; - Designing and conducting experiments to verify the laws of classical mechanics; - Apply the accumulated notions in relation to the specific knowledge of other chapters of physics

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Introduction. The place of mechanics between the classical branches of physics. Fundamental concepts: space, time, mass. Measures and units. Dimensional analysis.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	1 hour
2. Scalar quantities and vector quantities. Addition and subtraction of vectors. Scalar, vector, mixed product. Versors. **3. Coordinate systems in plane and space.** Cartesian coordinates. Versors of coordinate axes. Polar coordinates. Spherical coordinates. Cylindrical coordinates.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	1 hour
5. Types of mass point movements. Curvilinear movement. Motion with constant acceleration vector. Uniform rectilinear motion. Uniformly varied rectilinear motion. Oblique throwing in vacuum. Circular motion. Helical motion.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
6. Newton's laws. Statements and discussion. Defining the linear momentum. Inertial and non-inertial reference frames. Galilei transformations.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
7. The movement of the mass point under the influence of different types of forces. Constant force. Time-dependent force. Speed-dependent force. Friction with air. Position-dependent force. Applications.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	4 hours
8. Dynamics of the mass point. Theorem of linear momentum for a mass point. Torque. The angular momentum. Theorem of angular momentum for a mass point. Work. Power. Kinetic energy. Theorem of the variation of the kinetic energy. Potential energy. Conservative forces. Total energy. Conservation of mechanical energy. Friction forces.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	4 hours
9. Dynamics of the mass points system. Definition of the system of mass points. Internal and external forces. Theorem of linear momentum for a system of mass points. Theorem of angular momentum for a system of mass points. The theorem of the variation of the total kinetic energy. Energy conservation for a system of particles.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
10. The mass center of a system of mass points. Movement in the reference frame of the mass center and in the laboratory reference frame. Decomposition theorems.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
11. Collisions. Plastic collision. Elastic collision. Collision coefficients.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
12. Kinematics of the rigid body. Rigid body model. Translation and rotation. Composition of positions, velocities and accelerations of a rigid body. Poisson's formulas. Euler's formulas. Parallel plane motion.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
13. Rigid body dynamics. Kinetic energy of rotation. Work. The power. Angular momentum of rotation. The moment of inertia about an axis. The main axes of inertia. Steiner's theorem. Calculation of moments of inertia.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
14. Rigid body statics. Composition of parallel forces. Torque. Reducing a system of forces. Varignon's theorem. Equilibrium conditions. The center of gravity of a particle system. Guldin's and Pappus's theorems.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours

Bibliography:

- A. Hristev, *Mecanică și acustică*, Editura Didactică și Pedagogică, București, 1984.
- D. Kleppner, R. Kolenkow, *An Introduction to Mechanics*, 2nd edition, Cambridge University Press, 2013
- C. Kittel, W.D. Knight, M.A. Ruderman, *Cursul de Fizică Berkeley*, Volumul I, Mecanică, Editura Didactică și Pedagogică, București, 1981.
- A.P. French, *Newtonian Mechanics* (M.I.T. Introductory Physics), 1st. Edition, W. W. Norton & Company, 1971.
- A.P. French, *Vibrations and Waves* (M.I.T. Introductory Physics), Reprint Edition, W. W. Norton & Company,

1971 ▪ H. Goldstein, C. Poole, J. Safko, *Classical Mechanics*, 3rd Edition, Addison-Wesley, 2001. ▪ C. Berlic, *Note de curs* (pdf)		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
Presentation of the mechanics laboratory. Labor protection training. Use of measuring instruments.	Lecture. Debate. Examples.	2 hours
Dimensional analysis, errors and error calculus. Data presentation: tables and graphs. Use of specialized software.	Lecture. Debate. Examples. Guided practical activity.	2 hours
Free fall.	Guided practical activity.	2 hours
The simple pendulum. Determination of gravitational acceleration	Guided practical activity.	2 hours
Parallel axis theorem.	Guided practical activity.	2 hours
Reversible pendulum. Determination of gravitational acceleration	Guided practical activity.	2 hours
Dynamic study of torsion.	Guided practical activity.	2 hours
Tribometer	Guided practical activity.	2 hours
Measurement of moment of inertia and torque constant	Guided practical activity.	2 hours
Mach Pendulum	Guided practical activity.	2 hours
Determination of the elastic constant of a spring	Guided practical activity.	2 hours
Laboratory exan	Exam	2 hours
Bibliography: ▪ C. Ciucu, Cristina Miron, V. Barna, *Lucrări practice. Mecanică Fizică și Acustică (I)*, Ed. Universității din București, București, 2009. ▪ E. Barna, C. Ciucu, Cristina Miron, V. Barna, C. Berlic, *Lucrări practice. Mecanică Fizică și Acustică (II)*, Ed. Universității din București, București, 2010.		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 syllabus is consistent with the content of similar courses taught at universities in the country (Babeş-Bolyai University of Cluj Napoca, "Alexandru Ioan Cuza" University of Iași, West University of Timisoara) and abroad (University of Groningen, Netherlands, The University of Chicago, USA, MIT, USA, Technical University Wien, Austria, etc.), providing students with the formation of skills and abilities to analyze physical phenomena specific to classical mechanics, to plan and conduct specific experiments and to identify applications, abilities and skills of interest to business company and research institutes with activity in the field of physics, as well as in college education.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Knowledge of the fundamental notions in Classical Mechanics; - Appropriate achievement and correct understanding of the topics lectured in the course; - Demonstration of theoretical concepts correctly using the calculus equations; - Clarity, coherence and conciseness of the presentation; - The correct use of the studied physical models, formulas and calculus equations; - Ability to exemplify; - Ability to apply the acquired knowledge to solve mechanics exercises.	1. Mid-term examination. Partial examination of theoretical knowledge -written exam 2. Final examination. Examination of theoretical knowledge - written exam For online assessment, the subjects will be electronically sent via email / Google Classroom / Microsoft Teams, and during the exam students will have their video camera turned on, the exam being recorded.	35% 35%

10.5.1. Tutorial	-	-	-
10.5.2. Practical	- Familiarity with specific experimental techniques and infrastructure of the laboratory; - Applying specific methods of solving a given exercise; - Interpretation of results.	Colloquium examination	30%
10.5.3. Project	-	-	-

10.6. Minimal requirements for passing the exam
- Obtaining a minimum grade of 5 in each test.
- Understanding the notions of trajectory, speed and acceleration
- Knowledge and understanding of the Newton's laws
- Knowledge of conservation theorems and laws for the mass point and the system of mass points.
- Knowledge of the laws of collision.
- Understanding the notion of moment of inertia
- Calculation of moments of inertia for simple systems
- Knowledge of equilibrium conditions for the rigid body

Lessons attendance: at least 50% of the number of class hours and compulsory attendance at all laboratory sessions.

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 8.11.2021	Teacher’s name and signature Assoc. Prof. Catalin Berlic	Practicals/Tutorials instructor(s) name(s) and signature(s) Assoc. Prof. Catalin Berlic
Date of approval 11.11.2021	Head of Department Prof.univ.dr. Alexandru JIPA	

DI.104F.EN Molecular Physics and Heat I

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Molecular Physics and Heat I**								
2.2. Teacher				Conf. dr. Anca Dumitru					
2.3. Tutorials/Practicals instructor(s)				Conf. dr. Anca Dumitru					
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1]	DF
							Type[2]	DI

[1] fundamental (DF), speciality (DS), complementary (DC); [2] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in	4	distribution:	Lectures	2	Tutorials	-	Practicals	2	Project	-

curriculum										
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	-	Practicals	28	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	25
3.3.2. Research in library, study of electronic resources, field research	15
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	25
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	65
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competences	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphitheater equipped with multimedia devices
5.2. for practicals/tutorials	Set of practical work illustrating the topics covered in the course; Consumables; Computers and software for data analysis

6. Specific competences acquired

Professional competences	C1 - Identification and proper use of the key laws and principles of physics in a given context. C2 – Solving imposed condition physics problems C3 - Apply knowledge of physics in experiments using standard laboratory equipment C4 – Communication and analysis of didactic, scientific and dissemination of information
Transversal competences	CT1- Achievement of the professional duties in an efficient and responsible way with compliance with deontological legislation specific to the domain under qualified assistance. CT3 - Effective use of information, communication and training assistance, both in Romanian and in English.

7. Course objectives

7.1. General objective	The assimilation of general framework of macroscopic and microscopic studies of thermal phenomena
7.2. Specific objectives	Knowledge and understanding -Understanding of general structure of thermodynamics - The correct assimilation of thermodynamic laws for reversible and irreversible processes - The knowledge of description of thermodynamic system by state equations and the connections with response functions. - understanding the concepts of macroscopic studies of thermal phenomena Explanation and interpretation Connection between the theoretical concepts defined in lecture and experimental investigation in practical work in the laboratory. The practical application of the general principles in solving the concrete problems.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Introduction: Macroscopis description of system. Fundamental concepts. Thermodynamic system. Surroundings, State variables, Boundaries. Clasification of the thermodynamics systems. State variable. Clasification of state variable. Use of partial derivate in thermodynamics.	Systematic exposition - lecture. Conversation. Examples	2 horus
Thermal equilibrium and temperature. General law of	Systematic exposition -	4 hours

thermodynamics. The zero law of thermodynamics. Temperature measurement. Temperature scales. Temperature measurement devices. Pressure. Pressure measurement. Dalton Law of partial pressure.	lecture. Conversation. Examples	
Ideal gas laws. Thermal Equations of state. Thermal coefficients. General laws of thermal expansion. Applications of thermal coefficients. Cyclical relation. The relation between thermal coefficients. Equivalence between equation of state and the thermal coefficients for ideal gas.	Systematic exposition - lecture. Conversation. Examples. Problems.	4 hours
State and transfer variables. Reversible and irreversible processes. Heat. Mechanical work. Sign Conventions. The first law of thermodynamics (primary formulation and general statement). Caloric coefficients. Applications of the first law in the basic processes: adiabatic, isothermal, isochoric, isobaric and polytropic. Enthalpy. Phase changes. Latent Heat. Newton law of cooling. Caloric equation of state. Free expansion-Joule Experiment. Joule-Thomson Experiment.	Systematic exposition - lecture. Conversation. Examples. Problems.	4 hours
Primary statement of the second law of thermodynamics; Heat engine: monothermal and bithermal heat engine; Carnot Theorem; Absolute thermodynamics temperature; Clausius equality, Efficiency of the heat engine; Clausius' integral for reversible processes; Entropy and the general statement of the second law for reversible processes.	Systematic exposition - lecture. Conversation. Examples	4 hours
Entropy in reversible processes. Clausius inequality. Clausius' integral for irreversible processes. The general statement of the second law for irreversible processes. The general statement of the second law of thermodynamics. Entropy and irreversibility. The principle of maximal entropy. Properties of the entropy. Equivalent statements of the second law.	Systematic exposition - lecture. Conversation. Examples. Problems.	4 hours
Partial derivate and Maxwell relations. Fundamental equation of thermodynamics. Differential relationships between state functions and state parameters: a) T,V independent variable; b) P,T independent variable and c) P,V independent variable. TdS equations.	Systematic exposition - lecture. Conversation. Examples	2 hours
Heat engines: Stirling, Otto, Diesel and Brayton. Refrigerators. Heat pumps. Examples.	Systematic exposition - lecture. Conversation. Examples	2 hours
Review of the concepts and notions introduced in the Molecular Physics I.	Systematic exposition - lecture. Conversation. Examples	2 hours

Bibliography:

- V. Filip, Introductory Thermal Physics, Ed. Univ. Buc., 2006.
- Vlad Popa-Nita, Molecular physics (first part- Thermodynamics), Ed. Univ. Buc. (1994).
- S.Stefan, Fizica Moleculara, Ed. Univ. Bucuresti, 2006
- C.N. Plavitu, Fizica Fenomenelor Termice, Partea I, Ed. Hyperion, 1992
- S. Turns, Thermodynamics. Concepts and Applications. Ed. Cambridge University Press, 2006
- W. Greiner, L. Neise, H. Stocker, Thermodynamics and Statistical Mechanics, Ed. Springer, 2006
- S. Stefan si V. Filip, Fizica Fenomenelor Termice. Culegere de Probleme, Ed. Univ. Buc., 2002.

8.2. Tutorials [main themes]	Teaching and learning techniques	Observations

Bibliography: ...whatever you decide to indicate...		
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
▪ Introduction to experimental errors ▪ Fortin barometer ▪ Determination of specific heat of a solid body by calorimetric method. ▪ Verifying the Dalton' law of partial pressure. ▪ Determination of specific heat of a liquid by Hirn calorimeter. ▪ Latent heat of crystallization. ▪ Mechanical equivalent of heat ▪ Thermal equation of state for ideal gases ▪ Heat capacities of gases (isobaric and isochoric molar heat capacities) ▪ Joule-Thomson effect. ▪ Determination of relative density and molar mass of gases through effusion method	Guided practical activity	24 hours
Laboratory examination	Reports of practical works and oral examination	4h
Bibliography: 1. Sabina Stefan (coordonator) Fizica moleculară –Lucrari practice, Ed. Univ. Bucuresti. 2. http://www.fizica.unibuc.ro/Fizica/Studenti/Cursuri/Main.php		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography: ...whatever you decide to indicate...		

9. 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 forms competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and international standards. 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/expectations of the main employers of the graduates.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of knowledge and theminology used in thermal physics - ability to indicate/analyse specific examples - correct use of equations/mathematical methods/physical models and theories	1. Partial examination. Written test examination of theoretical competences. 2. Final examination. Written and oral test examinations of theoretical competences	30% 40%
10.5.1. Tutorials			
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to analyse and interpret the characterization data - ability to present and discuss the results	Examination of Lab reports	30%
10.5.3. Project [only if			

included in syllabus]			

10.6. Minimal requirements for passing the exam Fulfillment of at least 50% of each of the criteria that determine the final grade.
Requirements for mark 5 (10 points scale) Completion of 80% laboratory and mark 5 to the colloquium Minimal knowledge of the theoretical concepts and of the practical works such as: Thermodynamic system. Properties of state and process variable. General statement of first and second law of thermodynamics and their applications for isoprocesses. Thermal and caloric coefficient. Heat engines efficiency. 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
5.11.2021

Teacher’s name and signature
Conf dr. Anca Dumitru

Practicals/Tutorials instructor(s) name(s) and signature(s)
Conf. dr. Anca Dumitru

Date of approval
11.11.2021

Head of Department
Prof. dr. Alexandru Jipa

DI.107F.EN Scientific English I

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Foreign Languages and Literatures
1.3. Department	Department of Modern Languages
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Scientific English I							
2.2. Teacher				Lecturer Monica Oanca, PhD				
2.3. Tutorials/Practicals instructor(s)				-				
2.4. Year of study	I	2.5. Semester	I	2.6. Type of evaluation	C	2.7. Classification of course unit	Content 1)	DC
							Type 2)	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	-	Tutorials	1	Practicals	-	Project	-
3.2. Total hours per semester	14	distribution:	Lectures	-	Tutorials	14	Practicals	-	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	2
3.3.2. Research in library, study of electronic resources, field research	3
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	2
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	7
3.5. Total hours per semester	25
3.6. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	A good command of English – level B2
4.2. competencies	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	-
5.2. for tutorials/projects	If the seminar takes place in a classroom, a blackboard and a video projector are required The seminar can be held online, and each student is responsible for making sure that he/she has a microphone. It is advisable to turn the camera on during the seminar.

6. Specific competences acquired

Professional competencies	1. Defining and describing the main notions of grammar and vocabulary 2. Defining the five specific competencies: Understand a written text Understanding a listened message Conducting a conversation Delivering an oral presentation of a topic Writing compositions
Transversal competencies	1. Develop the reading skills in English to read texts needed for Physics classes and seminars 2. Writing a project on a physics topic that will be presented orally in front of the classmates 3. Write an essay on a Physics related topic

7. Course objectives

7.1. General objective	Understanding and using the specialized vocabulary necessary for reading texts and then elaborating essays on Physics related topics.
7.2. Specific objectives	1. Knowledge and understanding (knowledge and proper use of vocabulary related to Physics) Revise general knowledge of English and apply it to comprehension in Physics-related texts as mentioned in the seminar topics 2. Explanation and interpretation (explaining and interpreting some ideas, projects, processes, as well as the theoretical and practical contents of the discipline) Specialized expressions will be explained and commented upon; their use in the specific context of the English language will be emphasised. Some physics concepts will be translated and the difference between English and Romanian will be analysed. False friends, as well as structures that appear only in English will be mentioned. 3. Instrumental - applications (design, management and evaluation of specific practical activities; use of methods, techniques and tools for investigation and application). Students will use their computers to design PowerPoint presentations, as well as other tools to write their projects. 4. Attitudinal (manifestation of a positive and responsible attitude towards the scientific field / cultivation of a scientific environment focused on democratic values and relations / promotion of a system of cultural, moral and civic values / optimal and creative capitalization of one's own potential in activities) Students will develop the ability to use English texts for writing a seminar paper in English for one of the specialized seminars (in the field of physics). During the seminar the stress will be on originality and correct citation of sources. Students will be advised to assume their responsibility for their work and they will be taught to engage in various projects and in partnership with other specialists Teamwork – collaboration is encouraged, but provided that each participant has a well-defined contribution.

8. Contents

8.2. Tutorials	Teaching and learning techniques	Observations
▪ Motivation to become a physicist ▪ The Concept of error ▪ The rhythm of our life ▪ The Present Tenses ▪ Education ▪ The Past Tenses ▪ Finding the perfect job ▪ Distance and displacement ▪ Speed and velocity ▪ Kinematic equations ▪ Passive voice ▪ Causative ▪ Contrasting ideas 14. Students Presentations	In all seminars students will interact with one another and will have to solve vocabulary exercises and repeat grammar structures. Texts related to the proposed topics will be discussed and comprehension exercises will be done. Conversations on these topics will be initiated, and listening exercises will be conducted, too. Students will give PowerPoint presentations on topics related to one of the subjects studied.	All seminars will use specialized texts written by native speakers (excerpts from books, magazines, etc.), vocabulary and grammar exercises, as well as recordings of native English speakers.
Bibliography: McCarthy Michael, Felicity O' Dell, English Vocabulary in Use, (Upper Intermediate and Advanced), Cambridge University Press, 2002, 2005. McCarthy Michael, Felicity O' Dell, Test your English Vocabulary in Use, (Upper Intermediate and Advanced), Cambridge University Press, 2002, 2005 Dearholt, Jim, Career Paths, Mechanics, Express Publishing, 2012 Virginia Evans, Jenny Dooley, Upstream Intermediate, Express Publishing, 2015. Jan Bell Roger Gower, Advanced Expert , Coursebook, Pearson, 2017. P. Frauenfelder and P. Huber, Introduction to Physics, Translated by F. S. Levin and J. L. Weil, Pergamon Press, 1978.		

9. 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 seminars follow the format of the foreign language seminars within the University of Bucharest and are in accordance with the international standards regarding the level of linguistic competences.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.5.1. Tutorial	The ability to understand and use correctly the vocabulary discussed during the seminars	Evaluation by written tests Evaluation by oral tests portfolio	40% 40% 20%
10.6. Minimal requirements for passing the exam - correct acquisition of level B2 of English, - correct use of the main notions of grammar - correct use of specialized terms - solving all the classwork posted on Google Classroom			

Date 10.11.2021	Teacher's name and signature Lecturer Monica Oanca, PhD	Practicals/Tutorials instructor(s) name(s) and signature(s)

Date of approval
11.11.2021

Head of Department
Lect. univ. dr. Raluca Andreescu

DI.108F.EN Physical Education and Sport I

1. Study program

1.1. University	University of Bucharest

1.2. Faculty	-
1.3. Department	Department of Physical Education and Sports
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Physical Education and Sport I								
2.2. Teacher									
2.3. Tutorials/Practicals instructor(s)	Lector univ dr.Cătălin Șerban								
2.4. Year of study	I	2.5. Semester	I	2.6. Type of evaluation	V	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	0	Tutorials	0	Practicals	0	Project	0
3.2. Total hours per semester	14	distribution:	Lectures	0	Tutorials	0	Practicals	14	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	0
3.3.2. Research in library, study of electronic resources, field research	0
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	0
3.3.4. Examination	4
3.3.5. Other activities	7

3.4. Total hours of individual study	7
3.5. Total hours per semester	25
3.6. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competencies	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	-
5.2. for practicals/tutorials/projects	-

6. Specific competences acquired

Professional competencies	▪ Knowledge and understanding. -To acquire general knowledge about physical education and highlighting its specific content -To gain knowledge about the effects of motor activities on the body; To accumulate notions regarding the particularities of the physical education lesson at the level of non-profile higher education; -To apply the formative knowledge, in the field of physical education and sports, at the level of daily activities. ▪ Explanation and interpretation -To establish the objectives and tasks specific to the activities carried out; -To develop the capacity to practice systematic and independent physical exercises; -To capitalize on communication in sports as a way of social integration; -To develop the ability to understand, operate and expand motor activity in free time and recreation; -To develop the ability to capitalize on the positive effects of physical education on personality and quality of life; ▪ Instrumental – applications -To design and apply exercise programs adapted to the objectives of the activity carried out; -To coordinate, integrate and participate in sports activities; -To identify solutions regarding the optimization of free time;

	-To mobilize human resources in volunteer actions; -To know the evaluation methods specific to physical education.
Transversal competencies	-To integrate and participate in sports activities promoting the values of fair play; -To develop principled and constructive relationships with the social partners; -To adapt, in optimal conditions and in an efficient way, to new situations; -To develop pro-active attitudes, positive thinking and interpersonal relationships; - To be aware of the importance of exercising on maintaining an optimal state of health, increasing the body's endurance and increasing the capacity for physical and intellectual work.

7. Course objectives

7.1. General objective	To be aware of the importance of exercising on maintaining an optimal state of health, increasing the body's endurance and increasing the capacity for physical and intellectual work
7.2. Specific objectives	- Maintaining an optimal state of health of students and improving the resistance of their body to the action of environmental factors and the specifics of professional activity; - Ensuring superior indices of correct and harmonious physical development of the body; - Improving skills, motor skills and knowledge on the practice of a sport; - Cultivating the skills and habits of students to practice independently, in their free time, exercises and sports for corrective, fortifying, recreational or compensatory purposes; - Engaging the mass of students in the systematic activity of practicing physical exercises, tourism and sports; - Improving moral-volitional and intellectual qualities and traits, aesthetic sense and social responsibility

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Bibliography:		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals Numbei of hours -14	Teaching and learning techniques	Observations
Introductory lesson – 1h	Audiovisual techniques (Power Point presentation, teaching film presentation, audio material presentation)	Practical work
Initial verification -1h		
Learning the basic technique – aerobic gymnastics and fitness – 3h		
Learning the main tehnical elements with the ball (volleyball handball) – 4h		
Acquiring yhe main collective tactical action of attack end defense (volleyball handball) – 3h		
Intermediate verification- 2h		

Bibliography:

- Bibliografie Obligatorie:
- Ganciu, M., (coord), colectiv DEFS, 2013, *Curs de educaţie fizică pentru studenţii Universităţii din Bucureşti*, Editura Universităţii din Bucureşti, Bucureşti
- Ganciu, M., Aducovschi, D., Gozu, B., Stoica, A.M., Stoicoviciu, A., Gulap, M., Cristea, M., 2010, *Activitatea fizică independentă şi valorificarea prin mişcare a timpului liber – Vol.I*, Editura Universităţii din Bucureşti, Bucureşti
Stoica, A., 2011, *Curs practic de gimnastică aerobică pentru studenții din Universitatea din București.* Editura Universității din București
- Bibliografie facultativă:
- Colectivul DEFS, coord. Aducovschi D.,2008, *Sistemul de evaluare la educație fizică – pe discipline sportive – în Universitatea din Bucuresti*, Editura Universităţii din Bucureşti

▪ Colectivul DEFS, 2005, *Designul instrucţional în optimizarea instruirii echipelor reprezentative ale Universităţii din Bucureşti*, Editura Universităţii din Bucureşti C. Alte surse utile DVD-uri, internet

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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)

Physical education is a social activity with special contributions to the social-professional integration of young people. The formative function of physical education will contribute to the development of these qualities and abilities, which will allow the future specialist to acquire the chosen profession as quickly and better as possible, to practice it with high efficiency, to be able to engage in various social activities. to be able to act independently and creatively on the environment and on his own person.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture			
10.5.1. Tutorial			
10.5.2. Practical	- interest in the discipline through systematic - participation in practical lessons (1h / week)		60%
	- initial and intermediate testing by control tests and trials	individual assessment	30%
	- participation in sports competitions		10%
10.5.3. Project			
10.6. Minimal requirements for passing the exam • participation in 50% of the total number of lessons • passing motor tests • participation in a sports competition • to prove the minimum acquisition of the general notions of physical education and sports			

Date
10.11.2021

Teacher’s name and signature
Lector univ dr.Cătălin Șerban

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

Date of approval
11.11.2021

Head of Department
Prof. Stoica Alina, PhD

DI 109F.EN Equations of Mathematical 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	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Equations of Mathematical Physics								
2.2. Teacher				Conf. Dr. Radu Slobodeanu					
2.3. Tutorials instructor(s)				Conf. Dr. Radu Slobodeanu					
2.4. Year of study	I	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS	
							Type [2)]	DI	

1) fundamental (DF), specialty (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours / week in curriculum	5	distribution:	Lectures	2	Tutorials	3	Practical	-	Project	-
3.2. Total hours / semester	70	distribution:	Lectures	28	Tutorials	42	Practical	-	Project	-

3.3 Distribution of estimated time for study	Hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	11
3.3.3. Preparation for tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	51
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	The 1st year courses *Real and Complex Analysis* and *Algebra, Geometry and Differential equations*. High school mathematics
4.2. competences	Computational skills

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Classroom with video projector. Access to the library and to internet resources (Moodle or Google Classroom)
5.2. for tutorials/projects	Classroom with video projector. Mathematica software.

6. Specific competences acquired

Professional competencies	- solving physics problems using analytical, numerical and statistical methods - communication and analysis of information from Physics, with didactic purpose or for research and popularization. -cross-disciplinary approach of some topics in the area of Physics.
Transversal Competencies	Efficient use of informational sources and of professional training and dissemination resources in a worldwide spoken language.

7. Course objectives

7.1. General objective	Assimilation of various techniques of solving **partial differential equations** (**PDE)** of second order and integral equations.
7.2. Specific objectives	● Developing problem solving skills and programming skills with MATHEMATICA software for dealing with analytic methods in PDE and integral equations, Fourier expansion in orthogonal polynomials, Bessel functions, spherical harmonics functions. ● Developing the ability to interpret physically a mathematical result/solution and to formulate mathematically a

	physical hypothesis.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Elements of functional analysis. Hilbert spaces, Hilbert bases. Fourier trigonometric series. Linear and bounded operators on a Hilbert space. Linear functionals. Riesz theorem. The adjoint of a bounded linear operator on a Hilbert space.	Lecturing. Demonstrating (Examples). Classroom discussions.	3h
Compact operators. Eigenvalues and eigenvectors. Fredholm alternative. Applications to integral equations.	Idem	3h
Second-order linear differential equations. Power series method and Frobenius method.		2h
Sturm-Liouville theory and special functions. Regular Sturm-Liouville boundary value problems. Orthogonal polynomials. Bessel functions. Spherical harmonics. Applications to explicitly solvable quantum systems.	Idem	6h
Integral transforms. Laplace and Fourier transform. Applications in spectroscopy and imaging.	Idem	2h
Problems in the theory of partial differential equations. Initial and boundary conditions. The classification and the reduction to canonical form for semilinear second-order PDE.	Idem	2h
Elliptic equations. Green's identities and the integral representation formula with 3 potentials (Newtonian potential, simple layer and double layers potentials). Maximum principle, mean value theorem. Boundary value problems (Dirichlet and Neumann) for Laplace equation. Green's function for the interior Dirichlet problem. Applications in electrodynamics.	Idem	4h
Hyperbolic equations. Solutions of the wave equation in the cases of n=1,2,3. Domain of dependence, region of influence. Huygens' principle. The finite vibrating string problem. Separation of variables method.	Idem	2h
Parabolic equations. Maximum principle. The solution of the Cauchy's problem. Fourier's method of separation of variables for solving the mixed problem.	Idem	2h
Distribution theory. Operations with distributions, their Fourier transform. The notion of fundamental solution of a linear PDE, weak formulation of a PDE.	Idem	2h

Bibliography:

G. Arfken, H. Weber, F.E. Harris, *Mathematical Methods for Physicists*, 7th edition, Elsevier 2011.
I. Armeanu, *Functional Analysis* (in Romanian), Ed.Universității din București, 1998.
V. Barbu, *Partial differential equations and boundary value problems*, Springer, 2013.
V. Branzănescu, O. Stănășilă, *Special Topics in Mathematics* (in Romanian), Editura ALL 1998.
R. Courant, D. Hilbert, *Methods of Mathematical Physics*, Vol. 2, Partial Differential Equations, Wiley, 1989.
M. Reed, B. Simon, *Methods of Modern Mathematical Physics*, vol I-IV, Academic Press, 1972-1978
N. Teodorescu, V. Olariu, *Ordinary and Partial Differential Equations* (in Romanian) vol. I-III, Ed. Tehnică, 1978-1980.
A. N. Tikhonov, A. A. Samarskii, *Equations of Mathematical Physics*, Dover Publications, Reprint edition 2011.
V.S. Vladimirov, *Equations of mathematical physics*, Marcel Dekker, New York, 1971.
P.J. Olver, *Introduction to partial differential equations*, Springer, 2014.

8.2. Tutorials	Teaching & learning techniques	Observations
The seminar follows the course content. The problems arising in theoretical physics related to special functions, Fourier series expansion, Fourier transform will be supported with examples in MATHEMATICA.	Exercises and problem solving. Guided work	42h

Bibliography:

C. Constanda, *Solution techniques for elementary partial differential equations*, CRC Press, 2016.

P. DuChateau, D. W. Zachmann, *Theory and problems of partial differential equations*, **Schaum's outline series**, McGraw Hill, 1986. N.N. Lebedev, *Special Functions & Their Applications*, Dover Publications, 1972 Gh. Mocică, *Problems of Special Functions* (in Romanian), Editura Didactica si Pedagogica, 1988 P.J. Olver, *Introduction to partial differential equations*, Springer, 2014 R. Slobodeanu, A. Stoica, *Ecuațiile Fizicii Matematice. Introducere prin probleme rezolvate* (in Romanian), 2022. T. Stanasila, V.Olariu, *Ordinary and Partial Differential Equations* (in Romanian), Editura Tehnica,1982 V.S. Vladimirov, *A collection of problems on the equations of mathematical physics*, Springer, 2013.		
8.3. Practicals	Teaching and learning techniques	Observations
-	-	-
Bibliography: -		
8.4. Project	Teaching and learning techniques	Observations
-	-	-
Bibliography: -		

9. 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 and computational abilities that are mostly important for an undergraduate student in Physics, according to the (inter)national standards. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other Romanian as well as European universities.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - ability to apply theoretical results and the standard solving techniques in order to solve simple partial differential equations with initial/boundary value conditions. - ability to analyse specific examples	written exam (alternatively: two partial evaluations)	80%
10.5.1. Tutorial	Correct identification and application of the method needed for problem solving	Homeworks	20%
10.5.2. Practical	-	-	-
10.5.3. Project	-	-	-
10.6. Minimal requirements for passing the exam At least 50% of points at the exam and 50% of due homeworks**.** Being present at minimum 50% of the tutorials. Requirements for getting mark 5 (10 points scale) • Students must attend at least 50% of the lecture hours and at least 75% of the tutorial ones. • Fulfillment of at least 50% of each of the criteria that determine the final grade. 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
28.10.2021

Teacher’s name and signature
Conf.dr . Radu Slobodeanu

Practicals/Tutorials instructor(s) name(s) and signature(s)
Conf.dr . Radu Slobodeanu

Date of approval
11.11.2021

Head of Department
Lect.dr. Roxana ZUS

DI 110F.EN Complex Analysis

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	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Complex Analysis							
2.2. Teacher				Conf. Dr. Radu Slobodeanu				
2.3. Tutorials instructor(s)				Conf. Dr. Radu Slobodeanu				
2.4. Year of study	I	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DC
							Type 2)	DI

1) fundamental (DF), specialty (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours / week in curriculum	4	distribution:	Lectures	2	Tutorials	2	Practical	-	Project	-
3.2. Total hours / semester	56	distribution:	Lectures	28	Tutorials	28	Practical	-	Project	-

3.3 Distribution of estimated time for study	Hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	15
3.3.2. Research in library, study of electronic resources, field research	15
3.3.3. Preparation for tutorials/projects/reports/homeworks	10
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	The 1st semester courses *Real Analysis* and *Algebra, Geometry and Differential equations*. High school mathematics
4.2. competences	Computational skills

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Classroom with video projector. Access to the library and to internet resources (Moodle or Google Classroom)
5.2. for tutorials/projects	Classroom with video projector. Mathematica software.

6. Specific competences acquired

Professional competencies	- solving physics problems using analytical, numerical and statistical methods - communication and analysis of information from Physics, with didactic purpose or for research and popularization. -cross-disciplinary approach of some topics in the area of Physics.
Transversal Competencies	Efficient use of informational sources and of professional training and dissemination resources in a worldwide spoken language.

7. Course objectives

7.1. General objective	Knowledge, understanding and proper use of the fundamental concepts of

	complex analysis, with applications in physics. Acquiring a solid mathematical basis for understanding and modeling of physical phenomena.
7.2. Specific objectives	Knowledge and proper use of specific notions specific to complex analysis: holomorphic function, Cauchy-Riemann equations, contour integral, Taylor and Laurent series, residue theorem. Development of intuition and logical, abstract thinking. Develop the ability to work in a team. Development of computing skills.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Complex numbers. Operations with complex numbers, trigonometric representation. Elementary point set topology.	Lecturing. Demonstrating (Examples). Classroom discussions.	3h
Complex functions. Limits and continuity. Complex differentiability. Examples.	Idem	2h
Holomorphic functions. Cauchy-Riemann equations. Relation with harmonic functions.	Idem	4h
Complex Integration. Complex line integral. Cauchy's Theorem. Cauchy's Integral Formula. Applications	Idem	4h
Power Series. Taylor series and analyticity. Uniqueness and analytic continuation	Idem	3h
Laurent series and singularities. Classification of isolated singularities. Meromorphic functions	Idem	3h
The Calculus of Residues. Index of a point with respect to a closed curve. Residue of a holomorphic function at an isolated singularity. The Residue Theorem	Idem	3h
Evaluation of real integrals using the Residue Theorem.	Idem	3h
Conformal mapping. Riemann Mapping Theorem. Linear fractional transformations. Applications to potential theory problems (planar fluid flows, Laplace equation with boundary conditions, Poisson integral formula), and to Green's function for Poisson equation.	Idem	3h

Bibliography:

L. V. Ahlfors, *Complex Analysis. An Introduction to the Theory of Analytic Functions of One Complex Variable*, McGraw-Hill, 3rd edition 1979.
G. Arfken, H. Weber, *Mathematical Methods for Physicists*, Elsevier Academic Press, 2005.
N. Cotfas, L. Cotfas, *Elemente de analiză matematică* (in Romanian), Ed. Universității din București, 2010.
A. Halanay, V. Olariu, S. Turbatu, *Analiză matematică*, Ed. Didactică și Pedagogică, 1983. (in Romanian)
E. Kreyszig, *Advanced Engineering Mathematics*, 10th edition, Wiley, 2011.
W. Rudin, *Real and Complex Analysis*, McGraw-Hill, 1986.
E. M. Stein, R. Shakarchi, *Complex Analysis*, Princeton University Press, New Jersey, 2003.
I. Şandru, *Analiză complexă, note de curs*. (in Romanian),
C. Timofte, *Complex Analysis*, Ed. Universității din București, 2014.

8.2. Tutorials	Teaching & learning techniques	Observations
The seminar follows the course content. Some computation of power series and integrals will be supported with examples in MATHEMATICA.	Exercises and problem solving. Guided work	28h

Bibliography:

I. Armeanu, D. Blideanu, N. Cotfas, I. Popescu, I. Șandru, *Probleme de analiză complexă*, Ed.Tehnică, 1995 (in Romanian)
S. Lipschutz, J. Schiller, D. Spellman, M. Spiegel, *Schaum's Outline of Complex Variables*, 2nd ed. (Schaum's Outline Series), McGraw-Hill, New York, 2009.
K.F. Riley, M.P. Hobson, S.J. Bence, *Mathematical Methods for Physics and Engineering*, 3rd ed., Cambridge University Press, 2006.
P.J. Olver, *Complex analysis and conformal mapping*, University of Minnesota 806, 2017.

8.3. Practicals	Teaching and learning	Observations

	techniques	
-	-	-
Bibliography: -		
8.4. Project	Teaching and learning techniques	Observations
-	-	-
Bibliography: -		

9. 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 theoretical and practical skills and abilities that are important for undergraduate Physics students, corresponding to national and international standards. The content and teaching methods were chosen after an in-depth analysis of the content of similar course units in the curriculum of other universities in Romania or in the European Union. The content of the discipline is in accordance with the requirements and expectations of the representatives of the epistemic communities, of the professional associations and of the main employers of the future graduates in the field related to the program.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of arguments, capacity to cite appropriate general results from the course - ability to manipulate complex functions and the associated notions of complex differentiability and integrability - ability to analyse specific examples, to compute contour integrals using residues, expansion in power series and various planar potentials (using conformal mapping)	Written exam and oral assessment (online or "face to face"). For online assessment, topics will be submitted electronically, by email, or through Google Meet or Microsoft Teams platforms. The exam will be recorded and the students will have their video camera turned on.	80%
10.5.1. Tutorial	Ability to apply the specific results given in the course to problem solving. Ability to interpret correctly the results obtained.	Homeworks, seminar activity.	20%
10.5.2. Practical	-	-	-
10.5.3. Project	-	-	-
10.6. Minimal requirements for passing the exam At least 50% of points at the exam and 50% of due homeworks. Being present at minimum 75% of the tutorials and 50% of the lectures.			

Date 20.10.2021	Teacher’s name and signature Conf.dr. R. Slobodeanu	Practicals/Tutorials instructor(s) name(s) and signature(s) Conf.dr. R. Slobodeanu
Date of approval 11.11.2021	Head of Department Lect. dr. Roxana Zus	

DI.111F.EN Classical Mechanics II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics

1.3. Department	Department of Structure of the Matter, Earth and Atmospheric Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Classical Mechanics II								
2.2. Teacher				Associate Professor Cătălin Berlic					
2.3. Tutorials/Practicals instructor(s)				Associate Professor Cătălin Berlic					
2.4. Year of study	I	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DF	
							Type [2)]	DI	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	1	Tutorials	1	Practicals	1	Project	-
3.2. Total hours per semester	42	distribution:	Lectures	14	Tutorials	14	Practicals	14	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	14
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	54
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Attending the classes of Classical Mechanics I, Real Analysis, Algebra, Geometry and Differential Equations
4.2. competencies	Good level of understanding of algebraic calculus, elements of geometry, trigonometry and mathematical analysis. General physics knowledge.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia room (computer, video projector and projection screen)
5.2. for practicals/tutorials/projects	Laboratory with the necessary equipment for carrying out practical works. Computers, Video projector, software packages for data analysis and processing.

6. Specific competences acquired

Professional competencies	Identification and proper use of the main laws, notions and principles specific to mechanics. Solving classical mechanics exercises under imposed conditions. Carrying out mechanical experiments using standard laboratory equipment and evaluating the results based on theoretical models. Creative application of the knowledge acquired in order to understand and model the processes specific to classical mechanics. Communication and analysis of scientific information in the field of physics. Use of specific software packages for data analysis and processing.
Transversal competencies	Efficient use of information sources and communication and training resources. Carrying out professional tasks efficiently and responsibly in compliance with the legislation, ethics and deontology specific to the field, under qualified assistance. Applying efficient teamwork techniques, on various hierarchical levels.

7. Course objectives

7.1. General objective	Assimilation of concepts and laws specific to classical mechanics, development of students' ability to perform and interpret experimental works and problem solving specific to classical mechanics.
7.2. Specific objectives	- Analysis and modeling of mechanical movement; - Applied study from simple to complex following the specific conservation laws; - Applying the theoretical concepts in solving the problems of classical mechanics, as well as formulating rigorous and reasoned theoretical conclusions; - Designing and conducting experiments to verify the laws of classical mechanics; - Apply the accumulated notions in relation to the specific knowledge of other chapters of physics

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Gravity. Kepler's laws. Newton's law of gravity. Gravitational acceleration. Variation of gravitational acceleration with height. Cosmic speeds. The gravitational field.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
2. Movement in the central force field. The problem of the two bodies. Speed and acceleration. The integral of the kinetic moment. Integral energy. Orbits and trajectories.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
3. Relative and absolute kinematics and dynamics of movements. Absolute, relative and transport motion. Additions of displacements, speeds and accelerations. Non-inertial reference frames. Complementary forces. Coriolis force. Applications.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
4. Mechanics of elastic body. Stresses and deformations. Elongation of the bar. Hooke's law. Transverse contraction. Compressibility. Shearing. Bending. Torsion.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	2 hours
5. Fluid mechanics. Fluid statics. Hydrostatic pressure. Pascal's law. Archimedes' law. Fluid dynamics. Equation of continuity. The Bernoulli equation. Viscosity. Poiseuille's law. Stokes' law. Speed limit.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	3 hours
6. Oscillations and waves. Simple harmonic oscillator. Kinematics and dynamics of harmonic oscillatory motion. Harmonic oscillator energy. Propagation of a disturbance. Elastic waves. Definitions. Example.	Systematic exposition - lecture, demonstration, discussion, case study. Examples	3 hours

Bibliography:
- A. Hristev, *Mecanică și acustică*, Editura Didactică și Pedagogică, București, 1984.
- D. Kleppner, R. Kolenkow, *An Introduction to Mechanics*, 2nd edition, Cambridge University Press, 2013
- C. Kittel, W.D.Knight, M.A. Ruderman, *Cursul de Fizică Berkeley*, Volumul I, Mecanică, Ed. Didactică și Pedagogică, București, 1981.
- A.P. French, *Newtonian Mechanics (M.I.T. Introductory Physics)*, 1st. Edition, W. W. Norton & Company, 1971
- A.P. French, *Vibrations and Waves (M.I.T. Introductory Physics)*, Reprint Edition, W. W. Norton & Company, 1971
- H. Goldstein, C. Poole, J. Safko, *Classical Mechanics*, 3rd Edition, Addison-Wesley, 2001.
- C. Berlic, *Note de curs* (pdf)

8.2. Tutorials	Teaching and learning techniques	Observations
The syllabus of the tutorials follows the content of the lecture. The subjects discussed aim a deep understanding of the theoretical notions presented in the lecture, the development of calculation skills and the appropriate use of the fundamental concepts of Classical	Lecture, conversation, exercises, problems	14 ore

Mechanics.		

Bibliography:
- A. Hristev, *Probleme rezolvate de mecanică și acustică*, Ed. APH, București, 1999.
- V. Dima, E. Barna, *Mecanică și acustică. Probleme rezolvate,* Ed. Universității din București, 2006.
- C. Plăvițu, A. Hristev, L. Georgescu, D. Borșan, V. Dima, C. Stănescu, L. Ionescu, R. Moldovan, *Probleme de mecanică fizică și acustică,* Ed. Didactică și Pedagogică, București, 1981

8.3. Practicals	Teaching and learning techniques	Observations
Torsion of the rod	Guided practical activity	2 hours
The wind tunnel. Resistance forces	Guided practical activity	2 hours
The gyroscope.	Guided practical activity	2 hours
Coupled pendulums	Guided practical activity	2 hours
The surface of a rotating liquid	Guided practical activity	2 hours
Verification of Kepler's laws	Guided practical activity	2 hours
Laboratory exam	Exam	2 hours

Bibliography:
- C. Ciucu, Cristina Miron, V. Barna, *Lucrări practice. Mecanică Fizică și Acustică (I),* Ed. Universității din București, București, 2009.
- E. Barna, C. Ciucu, Cristina Miron, V. Barna, C. Berlic, *Lucrări practice. Mecanică Fizică și Acustică (II),* Ed. Universității din București, București, 2010.

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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 syllabus is consistent with the content of similar courses taught at universities in the country (Babeş-Bolyai University of Cluj Napoca, "Alexandru Ioan Cuza" University of Iași, West University of Timisoara) and abroad (University of Groningen, Netherlands, The University of Chicago, USA, MIT, USA, Technical University Wien, Austria, etc.), providing students with the formation of skills and abilities to analyze physical phenomena specific to classical mechanics, to plan and conduct specific experiments and to identify applications, abilities and skills of interest to business company and research institutes with activity in the field of physics, as well as in college education.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Knowledge of the fundamental notions in Classical Mechanics; - Appropriate achievement and correct understanding of the topics lectured in the course; - Demonstration of theoretical concepts correctly using the calculus equations; - Clarity, coherence and conciseness of the presentation; - The correct use of the studied physical models, formulas and calculus equations; - Ability to exemplify; - Ability to apply the acquired knowledge to solve mechanics exercises.	1. Mid-term examination. Partial examination of theoretical knowledge - written exam 2. Final examination. Examination of theoretical knowledge - written exam For online assessment, the subjects will be electronically sent via email / Google Classroom / Microsoft Teams, and during the exam students will have their video camera turned on, the exam being recorded.	20% 20%
10.5.1. Tutorial	- Ability to solve classical mechanical exercises.	Homework	30%
10.5.2. Practical	- Familiarity with specific experimental techniques and infrastructure of the laboratory;	Colloquium examination	30%

	- Applying specific methods of solving a given exercise; - Interpretation of results.		
10.5.3. Project	-	-	-
10.6. Minimal requirements for passing the exam - Obtaining a minimum grade of 5 in each test. - Understanding the notions of trajectory, speed and acceleration - Knowledge and understanding of the Newton's laws - Knowledge of conservation theorems and laws for the mass point and the system of mass points. - Knowledge of the laws of collision. - Understanding the notion of moment of inertia - Calculation of moments of inertia for simple systems - Knowledge of equilibrium conditions for the rigid body Lessons attendance: at least 50% of the number of class hours and compulsory attendance at all laboratory sessions.			

Date 14.10.2021	Teacher’s name and signature Assoc. Prof. Catalin Berlic	Practicals/Tutorials instructor(s) name(s) and signature(s) Assoc. Prof. Catalin Berlic

Date of approval 11.11.2021	Head of Department Prof.univ.dr. Alexandru JIPA

DI.112F.EN Molecular Physics and Heat II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Molecular Physics and Heat II							
2.2. Teacher				Conf. dr. Anca Dumitru				
2.3. Tutorials/Practicals instructor(s)				Conf. dr. Anca Dumitru				
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1)]	DF
							Type[2)]	DI

[1)] fundamental (DF), speciality (DS), complementary (DC); [2)] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	1	Tutorials	1	Practicals	1	Project	
3.2. Total hours per semester	42	distribution:	Lectures	14	Tutorials	14	Practicals	14	Project	
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography										20
3.3.2. Research in library, study of electronic resources, field research										14

3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	54
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	...some (preceding) courses
4.2. competences	...some previously formed competences / Not applicable

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphitheater equipped with multimedia devices
5.2. for practicals/tutorials	Set of practical work illustrating the topics covered in the course; Consumables; Computers and software for data analysis

6. Specific competences acquired

Professional competences	C1 - Identification and proper use of the key laws and principles of molecular physics and heat in a given context. C2 – Solving problems of molecular physics and heat C3 - Apply the theoretical knowledge of molecular physics and heat to evaluate the experimental data obtained in the laboratory C4 – Communication, analysis and dissemination of scientific information C5 Interdisciplinary approach to physics topics.
Transversal competences	CT1- Efficient and responsible fulfillment of the professional duties, while respecting the deontological laws of the domain, under qualified supervision. CT2 - Effective use of information, communication and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	The assimilation of general framework of macroscopic and microscopic studies of thermal phenomena
7.2. Specific objectives	Knowledge and understanding - Using the thermodynamic potentials and their derivate (Maxwell relation) in order to determine the properties of the system -Correlation between thermodynamic potential and spontaneity of a process -Behavior of real gas; - Phase Transition, Phase equilibrium and phase diagram -Microscopic study of thermal phenomena: kinetic and statistical approaches -Description of the thermal phenomena using macroscopic or microscopic approach Explanation and interpretation Connection between the theoretical concepts defined in lecture and experimental investigation in practical work in the laboratory. The practical application of the general principles in solving the concrete problems.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Method of thermodynamic potentials. Legendre Transformation. Entropy as characteristic function. Thermodynamic potentials: internal energy, enthalpy, Helmholtz free energy, Gibbs free enthalpy. Thermodynamic square. Applications of thermodynamic potentials. Spontaneity and Gibbs free enthalpy. Thermodynamic potentials for an open system. Chemical potential.	Systematic exposition - lecture. Conversation. Examples.	3 hours
The third law of thermodynamics.	Systematic exposition -	2 hours

Statement.Consequences. Equilibrium conditions for an isolated system. The principle of minimum of energy. Concept of phase. Phase Transition and chemical potential. Phase equilibrium and phase diagram. Gibbs phase rule. Clapeyron- Clausius Equation.	lecture. Conversation. Examples	
Van der Waals Equation of state. Critical temperature and associated constants. Compressibility Factor. Entropy and thermodynamic potential of van der Waals gas. Applications of van der Waals gas in isothermal and adiabatic process, Van der Waals gas equation for an adiabatic process. Carnot engine efficiency Relation between molar heat capacities of van der Waals gas.	Systematic exposition - lecture. Conversation. Examples. Problems.	2 hours
Introduction on the kinetic molecular theory of ideal gases. Assumptions of kinetic theory. Relationship between pressure and molecular kinetic energy. Molecular interpretation of temperature. Theorem of equipartition of energy. Degree of freedom. Molar heat capacities (revised).	Systematic exposition - lecture. Conversation. Examples	2 hours
Random variables. Mean and Standard deviation. Microstate, macrostate and multiplicity. Statistical view of Entropy. Boltzmann relation. Statistical versus thermodynamics definition of entropy.	Systematic exposition - lecture. Conversation. Examples	2 hours
Introduction in statistical physics. Statistical distribution law by positions. Statistical distribution law by velocity vector. Maxwell Velocity Distribution. Mean Speed, Most Probable Speed and Root-Mean-Square Speed. Conversion of velocity distribution to energy distribution. Molecular collision. Mean free path. Effusion. Molecular current and flow. Transport phenomena: diffusion, viscosity and thermal conductivity.	Systematic exposition - lecture. Conversation. Examples. Problems	3 hours
Bibliography: ▪ V. Filip, Introductory Thermal Physics, Ed. Univ. Buc., 2006. ▪ Vlad Popa-Nita, Molecular physics(second part- Thermodynamics), Ed. Univ. Buc. (1994).M. W. ▪ S.Stefan, Fizica Moleculara, Ed. Univ. Bucuresti, 2006 ▪ C.N. Plavitu, Fizica Fenomenelor Termice, Partea I, Ed. Hyperion, 1992 ▪ S. Turns, Thermodynamics. Concepts and Applications. Ed. Cambridge University Press, 2006 ▪ W. Greiner, L. Neise, H. Stocker, Thermodynamics and Statistical Mechanics, Ed. Springer, 2006 ▪ S. Stefan si V. Filip, Fizica Fenomenelor Termice. Culegere de Probleme, Ed. Univ. Buc., 2002.		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
The seminar follows the course content. The issues to be discussed are meant to provide the student with a better understanding of the application of theoretical concepts to solve problems or to evaluate the experimental data	Example. Problems. Guided work	10 hours
Bibliography: Similar wit the lectrure bibilography		
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations

▪ Determination of surface tension of a liquid/Determination of specific heat of a liquid by cooling method ▪ The viscosity of a liquid with Hoppler viscozimeter/Viscosity coefficient of air ▪ Verification of Stefan-Boltzmann's law of radiation ▪ Vapour pressure of water at high temperature ▪ Maxwellian velocity distribution	Guided practical activity	10 hours
Laboratory examination	Reports of practical works and oral examination	4h
Bibliography: 1. Sabina Stefan (coordonator) Fizica moleculară –Lucrari practice, Ed. Univ. Bucuresti. 2. http://www.fizica.unibuc.ro/Fizica/Studenti/Cursuri/Main.php		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography: ...whatever you decide to indicate...		

9. 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 forms competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and international standards. 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/expectations of the main employers of the graduates.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of knowledge and theminology used in thermal physics - ability to indicate/analyse specific examples - correct use of equations/mathematical methods/physical models and theories	Oral and written examination	50%
10.5.1. Tutorials	- ability to use specific problem solving methods; - ability to analyse the results; - ability to present and discuss the results	Homework	20%
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to analyse and interpret the characterization data - ability to present and discuss the results	Examination of Lab reports	30%
10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam Fulfillment of at least 50% of each of the criteria that determine the final grade.			
Requirements for mark 5 (10 points scale)			

The obligation to perform 80% of laboratory work. To obtain minimum the mark 5 from evaluation criteria. Minimal knowledge of the theoretical concepts and of the practical works such as: thermodynamic potentials (U,F,G, and H), van der Waals equation of state (eq. of state, Internal energy and entropy); kinetic theory (assumption, average kinetic energy, kinetic interpretation of temperature , molecule velocity) and Maxwell Velocity Distribution (Mean Speed, Most Probable Speed and Root-Mean-Square Speed)

Date
8.11.2021

Teacher's name and signature
Conf dr. Anca Dumitru

Practicals/Tutorials instructor(s) name(s) and signature(s)
Conf. dr. Anca Dumitru

Date of approval
11.11.2021

Head of Department
Prof. dr. Alexandru Jipa

DI.113F.EN Electricity and Magnetism

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Electricity and Magnetism							
2.2. Teacher				Associate ProfessorVlad-Andrei ANTOHE				
2.3. Tutorials/Practicals instructor(s)				Lecturer Cezar Tazlăoanu				
2.4. Year of study	1	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1]	DF
							Type[2]	DI

[1] fundamental (DF), speciality (DS), complementary (DC); [2] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	7	distribution: Lecture	3	Tutorials 1 / Practicals 3	4
3.2. Total hours per semester	98	distribution: Lecture	42	Tutorials 14 / Practicals 42	56
Distribution of estimated time for study					hours
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography					70
3.2.2. Research in library, study of electronic resources, field research					8
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks					14
3.2.4. Examination					4
3.2.5. Other activities					6

3.3. Total hours of individual study	98
3.4. Total hours per semester	200
3.5. ECTS	8

4. Prerequisites (if necessary)

4.1. curriculum	Real and complex calculus; Algebra, geometry, and differential equations, Mechanics
4.2. competences	Identify and make appropriate use of main physical laws and principles in a given context.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC)
5.2. for practicals/tutorials	Experimental setups for carrying out basic and fundamental experiments on

	electricity and magnetism

6. Specific competences acquired

Professional competences	▪ C1- Identify and make appropriate use of the main laws and principles of physics, in a given context. ▪ C1.3 – Understand how the main laws and principles in physics can be applied to solving simple theoretical and practical problems under qualified guidance. ▪ C2.3 - Make use of computers and data acquisition boards to control basic experiments or processes, and automation of experimental data collection. ▪ C4 – Carry out basic experiments in physics by using specific laboratory equipment. ▪ C5 – Analyze and communicate basic scientific, educational and popular information on physics.
Transversal competences	▪ CT3- Efficient use of trusted sources of scientific information and proficient communication of scientific data in English

7. Course objectives

7.1. General objective	Establish the grounding in electromagnetism in preparation for more advanced courses
7.2. Specific objectives	- Understand the huge step of abstraction when switching from mechanical point of view with forces, to the concept of field, using specific examples of the gravitational, electric and magnetic fields, with some applications. - Understand and analyze basic electric circuits - Understand the close connection between electricity and magnetism, leading to the discovery of electromagnetic waves - Knowledge and use of specific experimental methods connected to the study of electrical circuits and networks.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
ELECTROSTATICS: Fundamental interactions. Associated forces and fields in nature. Relative strength of fundamental interactions. The modern concept of charge.	Systematic exposition - lecture. Examples.	1 hour
Electric charges. Conservation and quantization of charge. Consequences.	Systematic exposition - lecture. Examples.	1 hour
Coulomb’s Law. The superposition principle.	Systematic exposition - lecture. Examples.	1 hour
The formalism of electrostatic field in vacuum. Electric field and electric potential. Properties.	Systematic exposition - lecture. Examples.	1 hour
Intensities and potentials. The superposition principle. Conservative nature of electrostatic field.	Systematic exposition - lecture. Examples.	1 hour
Point charge distributions and associated charge densities. Continuous charge distributions.	Systematic exposition - lecture. Examples.	2 hours
The moments of a charge distribution. The potential and the field of a dipole.	Systematic exposition - lecture. Examples.	1 hour
Gauss’ law. Integral and in point forms of Gauss’ Law. Laplace’s and Poisson’s equations. Consequences and applications.	Systematic exposition - lecture. Examples.	1 hour
Electrostatic energy of various systems of charges at rest. Electrostatic energy stored in electrostatic field. Meaning and consequences.	Systematic exposition - lecture. Examples.	1 hour
MATTER IN THE ELECTROSTATIC FIELD: The electrostatic field in matter. Ideal conductors and insulators under electrostatic field.	Systematic exposition - lecture. Examples.	1 hour
Electric displacement vector and electric polarization vector. Equations and properties.	Systematic exposition - lecture. Examples.	1 hour
Polarization of matter and electric permittivity.	Systematic exposition - lecture. Examples.	1hour
Capacitance and capacitors.		1 hour
STEADY STATE CURRENTS:	Systematic exposition - lecture.	2 hours

(DC) steady-state electrical currents. Current intensity and current density. Continuity equation.	Examples.	
Physics of conduction. Electric mobility and electric conductivity.	Systematic exposition - lecture. Examples. Lecture. Examples.	2 hours
Linear media and Ohm's Law. Electric resistance and resistors.	Systematic exposition - lecture. Examples. Lecture. Examples.	1 hour
Electromotive force and voltaic cells. Voltage sources and current sources. Principle of operation.	Systematic exposition - lecture. Examples. Lecture. Examples.	2 hours
STEADY STATE CURRENT CIRCUITS: Basic electric circuits. Kirchhoff's rules	Systematic exposition - lecture. Examples.	2 hours
Transient currents in RC circuits. Charging and discharging electric capacitors.	Systematic exposition - lecture. Examples.	1 hour
Power dissipation in electric circuits. Joule effect. In point Joule's Law.	Systematic exposition - lecture. Examples.	2 hours
MAGNETOSTATICS: Oersted discovery. The magnetic field due to DC steady-state currents. Lorentz force. Definition of magnetic flux density. Properties.	Systematic exposition - lecture. Examples.	2 hours
Biot-Savart Law. Integral and differential form of Ampere's Law. Magnetic forces on current carrying wires.	Systematic exposition - lecture. Examples.	2 hours
Vector potential and its properties.	Systematic exposition - lecture. Examples.	2 hours
Inductances, self-inductances, and mutual inductances. Magnetic moments.	Systematic exposition - lecture. Examples.	2 hours
Electromagnetic induction. Faraday's Law. Applications.	Systematic exposition - lecture. Examples.	2 hours
ALTERNATING CURRENT Alternating current (AC) circuits. Impedances and admittances. Resonance and physical meaning.	Systematic exposition - lecture. Examples.	2 hours
Power and energy in alternating-current Circuits.	Systematic exposition - lecture. Examples.	2 hours
Matter under magnetic field. Magnetic properties.	Systematic exposition - lecture. Examples.	2 hours
ELECTROMAGNETIC FIELD. MAXWELL EQUATIONS. ELECTROMAGNETI WAVES Electromagnetic waves and energy stored in electromagnetic field. Consequences.	Systematic exposition - lecture. Examples.	2 hours
Recommended lectures: 1. Stefan ANTOHE, Electricitate şi Magnetism, Vol. I, Editura Universităţii din Bucureşti, 1999. 2. Stefan ANTOHE, Electricitate şi Magnetism, Vol. II, Editura Universităţii din Bucureşti, 2002. 3. Edward M. Purcell, Electricitate şi Magnetism, Berkeley Physics Course, Vol. II, Editura Didactica şi Pedagogică, Bucuresti, 1982. 4. R. P. Feynman, R. B. Leighton, M. Sands, The Feynman Lectures on Physics, Vol. 2, Addyson-Wesley, 1964.		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
Calculus of the electric field strength and potential for discrete systems of charges. Problems solving.	Systematic exposition – and applications.	1 hour
Calculus of the electric field strength and potential for continuum charge distributions. Problems solving.	Systematic exposition – and applications.	1 hour
Gauss's Law. Applications to systems with high degree of symmetry. Problems solving.	Systematic exposition – and applications.	2 hours
Poisson and Laplace Equations. Applications to systems with high degree of symmetry. Problems solving.	Systematic exposition – and applications.	1 hour
Calculus of the dipole-dipole interactions. Problems solving.	Systematic exposition – and applications.	1 hour
Delta Y transformations for the equivalent resistance of a part of a complex DC network. Problems solving.	Systematic exposition – and applications.	1 hour
Calculus of the capacitance and potential coefficients. Problems solving.	Systematic exposition – and applications.	1 hour
Special methods for the steady state circuits analysis. Problems	Systematic exposition – and	2 hours

solving	applications.	
Applications of Biot-Savart-Laplace Law. Problems solving	Systematic exposition – and applications.	1 hour
Applications of the low of magnetic circuits. Problems solving.	Systematic exposition – and applications.	1 hour
Special methods for the alternating current circuits analysis. Problems solving	Systematic exposition – and applications.	2 hours
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
Electrostatic interaction of point charges. Coulomb's Law.	Guided practical activity	1 hour
Millikan experiment and charge quantization.	Guided practical activity	2 hours
Conductors at electrostatic equilibrium. Charge vs potential.	Guided practical activity	1 hour
The electrostatic capacitance of parallel plate capacitors.	Guided practical activity	2 hours
Using voltmeters and ammeters in various configurations: upstream and downstream connections for measuring electrical resistances.	Guided practical activity	2 hours
Measuring electrical resistances using Wheatstone Bridge and Kelvin method.	Guided practical activity	2 hours
Measurement of electric resistivity for various metals: Al, Cu.	Guided practical activity	2 hours
The effect of temperature on electrical resistivity of metals and semiconductors.	Guided practical activity	2 hours
Potentiometric measurements: precise measurements of electromotive forces.	Guided practical activity	2 hours
Thermoelectric effects (Peltier and Seebeck effects). Applications.	Guided practical activity	2 hours
The narrow electron beam tube. Principle of oscilloscope operation.	Guided practical activity	2 hours
Current-Voltage characteristics of a vacuum diode.	Guided practical activity	2 hours
Current-Voltage characteristics of semiconductor diodes.	Guided practical activity	1 hour
Biot-Savart Law. Measuring the magnetic density of flux of circular coils and solenoids.	Guided practical activity	2 hours
Measurement of Earth's Magnetic Field.	Guided practical activity	2 hours
Specific charge of the electron.	Guided practical activity	2 hours
Magnetic moment in the magnetic field.	Guided practical activity	1 hour
Ferromagnetic hysteresis.	Guided practical activity	1 hour
The Hall Effect.	Guided practical activity	2 hours
The Faraday's electromagnetic induction law.	Guided practical activity	1 hour
The transient regime in RLC circuits. Damped oscillations.	Guided practical activity	1 hour
Resonance phenomena in series and parallel AC circuits.	Guided practical activity	1 hour
Coupled Oscillating Circuits.	Guided practical activity	1 hour
The Ohm's laws for AC circuits.	Guided practical activity	1 hour
Kirchhoff's laws for AC circuits.	Guided practical activity	1 hour
Measurements with AC Wheatstone Bridge.	Guided practical activity	1 hour
Power measurements in DC and AC circuits.	Guided practical activity	1 hour
The power characteristics of a single-phase transformer.	Guided practical activity	1 hour
Recommended lectures: 1. I. Secăreanu, V. Ruxandra, M. Logofătu, S. Antohe, Electricitate şi magnetism, Lucrări de laborator, Tipografia Universităţii din Bucureşti, 1988. 2. P. Cristea and S. Antohe, Experiments on electricity and magnetism (will be printed)		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography:		

9. 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 aims at developing specific theoretical, practical competences, and abilities in the field of electric phenomena and electromagnetism. The content corresponds to all national and European/international standards. The content of lectures and the teaching methods were carefully selected and framed after the content of similar lecture units in the general syllabus of known universities from Romania, European Union, and US top universities. All lectures and

the proposed experiments comply with the high standards requirements and expectations of our main employers of the graduates (industry, research – e.g. the National R&D Institute for Materials Physics, elementary and high school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyze specific examples	Written test/oral examination	30%/30%
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Short lab written reports and practical examination	40%
10.6. Minimal requirements for passing the exam All practical activities attended and completed.			
Requirements for mark 5 (10 points scale) - Carrying out all mandatory experiments and completing all of written short reports. - Correct answer to basic questions and knowledge of basic laws of electromagnetism.			

Date 10.11.2021	Teacher's name and signature Assoc. Prof. Ph.D. Eng. Vlad-Andrei ANTOHE	Practical instructor, name(s) and signature(s) Lecturer Ph.D. Cezar TAZLĂOANU
Date of approval 11.11.2021	Head of Department, Assoc. Prof. Ph.D. Adrian RADU	

DI.114F.EN Processing of Physical Data and Numerical Methods

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Processing of Physical Data and Numerical Methods							
2.2. Teacher				Lect.dr. Roxana ZUS				
2.3. Tutorials/Practicals instructor(s)				Lect.dr. Roxana ZUS				
2.4. Year of study	1	2.5. Semester	II	2.6. Type of evaluation	C	2.7. Type of course unit	Content[1)]	DS
							Type[3)]	DFac

3. Total estimated time (hours/semester)

3.1. Hours per week	2	distribution:	Lecture	1	Tutorials		Practicals	1	Project	
3.2. Total hours per semester	28	distribution:	Lecture	14	Tutorials		Practicals	14	Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	15
3.3.2. Research in library, study of electronic resources, field research	10
3.3.3. Preparation for practicals/tutorials/projects/reports/homework	18
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	43
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Programming Languages, Algebra, Analysis, Differential Equations
4.2. competences	Knowledge of programming, linear algebra, analysis, differential equations

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Computer, Video projector Lecture notes Bibliography
5.2. for practicals/tutorials	Computer network Lecture notes Bibliography

6. Specific competences acquired

Professional competences	- Identifying and using the right physical laws and principles in given conditions - Using of dedicated software for data analysis and processing. - Solving physics problems in given conditions, using numerical and statistical methods.
Transversal competences	- Performing professional tasks in an efficient and responsible manner in compliance with the legislation and deontology specific to the field under qualified assistance. - Effective use of information sources, communication and training resources in a foreign language.

7. Course objectives

7.1. General objective	Learning techniques of numerical simulation for solving of problems and data analysis
7.2. Specific objectives	- Understanding specific problematic and correlation between analytic and applicative aspects; - Developing abilities for numerical simulation; - Developing abilities for adapting numerical algorithms to physics problems; - Developing abilities for data analysis and interpretation from numerical estimations and to formulate rigorous theoretical conclusions.

8. **Contents**

8.1. Lecture [chapters]	Teaching techniques	Observations
1. Solution of Linear Algebraic Equations Direct Methods: Gaussian Elimination, LU decomposition Iterative Methods: Jacobi, Gauss-Seidel, Singular value decomposition	Systematic exposition - lecture. Critical analysis. Examples	3 hours
2. Non-linear Equations and Roots of Polynomials Fixed point method, Bisection method, Newton-Raphson method, False Positon Method Secant Method, Laguerre's method of calculating polynomial roots	Systematic exposition - lecture. Critical analysis. Examples	3 hours
3. Function approximation Polynomial interpolation: Lagrange, Newton Continuous least squares approximation (orthogonal	Systematic exposition - lecture. Critical analysis. Examples	3 hours

polynomials, trigonometric polynomials) Discrete least squares approximation (least squares approximations, discrete orthogonal polynomials, Chebyshev)		
4. Numerical Evaluation of Derivatives and integrals Direct derivation. Derivation by interpolation. Classical formulas (the rectangle method, the trapezoidal method, Simpson method etc) Gauss Integration (Legendre, Hermite, Laguerre, Chebyshev) Monte-Carlo methods	Systematic exposition - lecture. Critical analysis. Examples	3 hours
6. Numerical Solution of Ordinary Differential Equations Direct Methods for Initial Value Problems Euler's Method of order I Euler's Method of order II Runge-Kutta Methods	Systematic exposition - lecture. Critical analysis. Examples	2 hours

Bibliography:

-K. Atkinson, "*An Introduction to Numerical Analysis*", 2nd ed., John WileyPub., 1989
- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, "*Numerical Recipes: The Art of Scientific Computing*", 3rd ed.,Cambridge University Press, 2007
- R. Burden, J. D. Faires, "*Numerical Analysis*", Thomson Brooks/Cole, 2010
- George W. Collins , "*Fundamental Methods and Data Analysis*", 2003
- Morten Hjorth-Jensen , "*Computational Physics*", University of Oslo, 2006
- C.Brebente, S.Mitran, S.Zancu, "Metode *Numerice*", Ed.Tehnică, 1997
- Roxana Zus, *Lecture notes* (pdf)

8.2. Tutorials [main themes]	Teaching and learning techniques	Observations

8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
Environment for programming the numerical methods exposed in the lecture	Systematic exposition. Heuristic conversation. Guided practical activity	1 hour
Programming the methods for solving linear algebraic equations. Applications in physics.	Guided practical activity	3 hours
Programming the methods for solving non-linear equations and finding roots of polynomials. Applications in physics.	Guided practical activity	3 hours
Interpolation and extrapolation of data points. Function approximation.	Guided practical activity	2 hours
Numerical derivation.	Guided practical activity	1 hour
Programming the methods for numerical solution of integrals. Applications in physics.	Guided practical activity	2 hours
Programming the methods for numerical solution of ordinary differential equations. Applications in physics.	Guided practical activity	2 hours

Bibliography:

- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, "*Numerical Recipes: The Art of Scientific Computing*", 3rd ed.,Cambridge University Press, 2007
- R. Burden, J. D. Faires, "*Numerical Analysis*", Thomson Brooks/Cole, 2010
- George W. Collins , "*Fundamental Methods and Data Analysis*", 2003
- Morten Hjorth-Jensen , "*Computational Physics*", University of Oslo, 2006
- Roxana Zus, Adrian Stoica, laboratory notes in electronic format

8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations

Bibliography:

9. 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)

For the elaboration of the contents, of the teaching and learning methods, the teachers have consulted the corresponding lectures from national and international universities.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	The understanding and correct use of the theoretical knowledge, clarity of exposition, logical coherence	Written test (final examination) Homework during the lecture	30% 20%
10.5.1. Tutorials			
10.5.2. Practicals	- ability to apply specific methods for a given problem - ability to present and discuss the results	Evaluation through individual homework at the end of the semester	50%
10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam Frequency: 50% lecture attendance and attendance to all tutorials and practicals Requirements for mark 5 (10 points scale) Correct exposition of 50% from the theoretical topics at the final exam. Correct numerical solution of one problem at the final exam.			

Date
04.11.2021

Teacher’s name and signature
Lect.dr. Roxana ZUS

Practicals/Tutorials instructor(s) name(s) and signature(s)
Lect.dr. Roxana ZUS

Date of approval
11.11.2021

Head of Department
Lect.dr. Roxana ZUS

DI.115F.EN Scientific English II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Foreign Languages and Literatures
1.3. Department	Department of Modern Languages
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

<table>
<tr><td colspan="3">2.1. Course unit title</td><td colspan="7">Scientific English II</td></tr>
<tr><td colspan="5">2.2. Teacher</td><td colspan="5">Lecturer Monica Oanca, PhD</td></tr>
<tr><td colspan="5">2.3. Tutorials/Practicals instructor(s)</td><td colspan="5">-</td></tr>
<tr><td rowspan="2">2.4. Year of study</td><td rowspan="2">I</td><td rowspan="2">2.5. Semester</td><td rowspan="2">II</td><td rowspan="2">2.6. Type of evaluation</td><td rowspan="2">C</td><td rowspan="2">2.7. Classification of course unit</td><td>Content 1)</td><td colspan="2">DC</td></tr>
<tr><td>Type 2)</td><td colspan="2">DI</td></tr>
</table>

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	-	Tutorials	1	Practicals	-	Project	-
3.2. Total hours per semester	14	distribution:	Lectures	-	Tutorials	14	Practicals	-	Project	-

3.3 Distribution of estimated time for study	
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	2
3.3.2. Research in library, study of electronic resources, field research	3
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	2
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	7
3.5. Total hours per semester	25
3.6. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	A good command of English – level B2
4.2. competencies	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	-
5.2. for tutorials/projects	If the seminar takes place in a classroom, a blackboard and a video projector are required The seminar can be held online, and each student is responsible for making sure that he/she has a microphone. It is advisable to turn the camera on during the seminar.

6. Specific competences acquired

Professional competencies	1. Defining and describing the main notions of grammar and vocabulary 2. Defining the five specific competencies: Understand a written text Understanding a listened message Conducting a conversation Delivering an oral presentation of a topic Writing compositions
Transversal competencies	1. Develop the reading skills in English to read texts needed for Physics classes and seminars 2. Writing a project on a physics topic that will be presented orally in front of the classmates 3. Write an essay on a Physics related topic

7. Course objectives

7.1. General objective	Understanding and using the specialized vocabulary necessary for reading texts and then elaborating essays on Physics related topics.
7.2. Specific objectives	1. Knowledge and understanding (knowledge and proper use of vocabulary related to Physics) Revise general knowledge of English and apply it to comprehension in Physics-related texts as mentioned in the seminar topics 2. Explanation and interpretation (explaining and interpreting some ideas, projects, processes, as well as the theoretical and practical contents of the discipline) Specialized expressions will be explained and commented upon; their use in the specific context of the English language will be emphasised. Some physics concepts will be translated and the difference between English and Romanian will be analysed. False friends, as well as structures that appear only in English will be mentioned. 3. Instrumental - applications (design, management and evaluation of specific practical activities; use of methods, techniques and tools for investigation and application). Students will use their computers to design PowerPoint presentations, as well as other tools to write their projects. 4. Attitudinal (manifestation of a positive and responsible attitude towards the scientific field / cultivation of a scientific environment focused on democratic values and relations / promotion of a system of cultural, moral and civic values / optimal and creative capitalization of one's

	own potential in activities) Students will develop the ability to use English texts for writing a seminar paper in English for one of the specialized seminars (in the field of physics). During the seminar the stress will be on originality and correct citation of sources. Students will be advised to assume their responsibility for their work and they will be taught to engage in various projects and in partnership with other specialists Teamwork – collaboration is encouraged, but provided that each participant has a well-defined contribution.

8. Contents

8.2. Tutorials	Teaching and learning techniques	Observations
▪ Science and Technology	In all seminars students will interact with one another and will have to solve vocabulary exercises and repeat grammar structures. Texts related to the proposed topics will be discussed and comprehension exercises will be done. Conversations on these topics will be initiated, and listening exercises will be conducted, too. Students will give PowerPoint presentations on topics related to one of the subjects studied.	All seminars will use specialized texts written by native speakers (excerpts from books, magazines, etc.), vocabulary and grammar exercises, as well as recordings of native English speakers.
▪ Physics: A Window on the Universe		
▪ How to do an experiment		
▪ Expectations and results		
▪ If- clauses		
▪ Intuition – a necessary quality for a researcher		
▪ Time- clauses		
▪ The ecological crisis		
▪ Fighting against Pollution		
▪ Wind Power Energy		
▪ Verb followed by ing – form or to-infinitiv		
12. The advantages of living in the city versus the countryside		
▪ Global issues		
14. Students' projects		

Bibliography:
McCarthy Michael, Felicity O' Dell, English Vocabulary in Use, (Upper Intermediate and Advanced), Cambridge University Press, 2002, 2005.
McCarthy Michael, Felicity O' Dell, Test your English Vocabulary in Use, (Upper Intermediate and Advanced), Cambridge University Press, 2002, 2005
Dearholt, Jim, Career Paths, Mechanics, Express Publishing, 2012
Virginia Evans, Jenny Dooley, Upstream Intermediate, Express Publishing, 2015.
Jan Bell Roger Gower, Advanced Expert , Coursebook, Pearson, 2017.
P. Frauenfelder and P. Huber, Introduction to Physics, Translated by F. S. Levin and J. L. Weil, Pergamon Press, 1978.

9. 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 seminars follow the format of the foreign language seminars within the University of Bucharest and are in accordance with the international standards regarding the level of linguistic competences.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.5.1. Tutorial	The ability to understand and use correctly the vocabulary discussed during the seminars	Evaluation by written tests Evaluation by oral tests portfolio	40% 40% 20%
10.6. Minimal requirements for passing the exam - correct acquisition of level B2 of English, - correct use of the main notions of grammar - correct use of specialized terms - solving all the classwork posted on Google Classroom			

Date 10.11.2021	Teacher's name and signature Lecturer Monica Oanca, PhD	Practicals/Tutorials instructor(s) name(s) and signature(s)

Date of approval
11.11.2021

Head of Department
Lect. univ. dr. Raluca Andreescu

DI.116F.EN Physical Education and Sport II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	-
1.3. Department	Department of Physical Education and Sports
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Physical Education and Sport II							
2.2. Teacher								
2.3. Tutorials/Practicals instructor(s)	Lector univ dr.Cătălin Șerban							
2.4. Year of study	I	2.5. Semester	II	2.6. Type of evaluation	V	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	0	Tutorials	0	Practicals	0	Project	0
3.2. Total hours per semester	14	distribution:	Lectures	0	Tutorials	0	Practicals	14	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	0
3.3.2. Research in library, study of electronic resources, field research	0
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	0
3.3.4. Examination	4
3.3.5. Other activities	7

3.4. Total hours of individual study	7
3.5. Total hours per semester	25
3.6. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competencies	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	-
5.2. for practicals/tutorials/projects	-

6. Specific competences acquired

Professional competencies	▪ Knowledge and understanding. -To acquire general knowledge about physical education and highlighting its specific content -To gain knowledge about the effects of motor activities on the body; To accumulate notions regarding the particularities of the physical education lesson at the level of non-profile higher education; -To apply the formative knowledge, in the field of physical education and sports, at the level of daily activities.

	▪ Explanation and interpretation -To establish the objectives and tasks specific to the activities carried out; -To develop the capacity to practice systematic and independent physical exercises; -To capitalize on communication in sports as a way of social integration; -To develop the ability to understand, operate and expand motor activity in free time and recreation; -To develop the ability to capitalize on the positive effects of physical education on personality and quality of life; ▪ Instrumental – applications -To design and apply exercise programs adapted to the objectives of the activity carried out; -To coordinate, integrate and participate in sports activities; -To identify solutions regarding the optimization of free time; -To mobilize human resources in volunteer actions; -To know the evaluation methods specific to physical education.
Transversal competencies	-To integrate and participate in sports activities promoting the values of fair play; -To develop principled and constructive relationships with the social partners; -To adapt, in optimal conditions and in an efficient way, to new situations; -To develop pro-active attitudes, positive thinking and interpersonal relationships; - To be aware of the importance of exercising on maintaining an optimal state of health, increasing the body's endurance and increasing the capacity for physical and intellectual work.

7. Course objectives

7.1. General objective	To be aware of the importance of exercising on maintaining an optimal state of health, increasing the body's endurance and increasing the capacity for physical and intellectual work
7.2. Specific objectives	- Maintaining an optimal state of health of students and improving the resistance of their body to the action of environmental factors and the specifics of professional activity; - Ensuring superior indices of correct and harmonious physical development of the body; - Improving skills, motor skills and knowledge on the practice of a sport; - Cultivating the skills and habits of students to practice independently, in their free time, exercises and sports for corrective, fortifying, recreational or compensatory purposes; - Engaging the mass of students in the systematic activity of practicing physical exercises, tourism and sports; - Improving moral-volitional and intellectual qualities and traits, aesthetic sense and social responsibility

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Bibliography:		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals Numbei of hours -14	Teaching and learning techniques	Observations
Introductory lesson – 1h	Audiovisual techniques (Power Point presentation, teaching film presentation, audio material presentation)	Practical work
Initial verification -1h		
Consolidation the technique – aerobic gymnastics and fitness – 3h		
Consolidation main tehnical elements with the ball (volleyball handball) – 4h		

Acquiring yhe main collective tactical action of attack end defense (volleyball handball) – 3h		
Intermediate verification- 2h		

Bibliography:
- Bibliografie Obligatorie:
- Ganciu, M., (coord), colectiv DEFS, 2013, *Curs de educaţie fizică pentru studenţii Universităţii din Bucureşti*, Editura Universităţii din Bucureşti, Bucureşti
- Ganciu, M., Aducovschi, D., Gozu, B., Stoica, A.M., Stoicoviciu, A., Gulap, M., Cristea, M., 2010, *Activitatea fizică independentă şi valorificarea prin mişcare a timpului liber – Vol.I,* Editura Universităţii din Bucureşti, Bucureşti

Stoica, A., 2011, *Curs practic de gimnastică aerobică pentru studenții din Universitatea din București.* Editura Universității din București
- Bibliografie facultativă:
- Colectivul DEFS, coord. Aducovschi D.,2008, *Sistemul de evaluare la educaţie fizică – pe discipline sportive – în Universitatea din Bucuresti*, Editura Universităţii din Bucureşti
- Colectivul DEFS, 2005, *Designul instrucţional în optimizarea instruirii echipelor reprezentative ale Universităţii din Bucureşti,* Editura Universităţii din Bucureşti

C. Alte surse utile
DVD-uri, internet

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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)

Physical education is a social activity with special contributions to the social-professional integration of young people. The formative function of physical education will contribute to the development of these qualities and abilities, which will allow the future specialist to acquire the chosen profession as quickly and better as possible, to practice it with high efficiency, to be able to engage in various social activities. to be able to act independently and creatively on the environment and on his own person.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture			
10.5.1. Tutorial			
10.5.2. Practical	- interest in the discipline through systematic - participation in practical lessons (1h / week)		60%
	- initial and intermediate testing by control tests and trials	individual assessment	30%
	- participation in sports competitions		10%
10.5.3. Project			

10.6. Minimal requirements for passing the exam
- participation in 50% of the total number of lessons
- passing motor tests
- participation in a sports competition
- to prove the minimum acquisition of the general notions of physical education and sports

Date 10.11.2021	Teacher’s name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s) Lector univ dr.Cătălin Șerban

Date of approval
11.11.2021

Head of Department
Prof. Stoica Alina, PhD

DI 201F.EN Optics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Optics							
2.2. Teacher	Conf. Dr. Mircea BULINSKI, Lect. Dr. Ing. Ovidiu Toma Conf. Dr. Mircea BULINSKI, Lect. Dr. Ing. Ovidiu Toma							
2.3. Tutorials/Practicals instructor(s)	Conf. Dr. Mircea BULINSKI, Lect. Dr. Ing. Ovidiu Toma Conf. Dr. Mircea BULINSKI, Lect. Dr. Ing. Ovidiu Toma							
2.4. Year of study	2	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1]	DF
							Type [2]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	7	distribution:	Lectures	3	Tu 1	Practicals	3	Project	-
3.2. Total hours per semester	98	distribution:	Lectures	42	Tu 14	Practicals	42	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	38
3.3.2. Research in library, study of electronic resources, field research	25
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	35
3.3.4. Examination	4
3.3.5. Other activities	X

3.4. Total hours of individual study	98
3.5. Total hours per semester	200
3.6. ECTS	8

4. Prerequisites (if necessary)

4.1. curriculum	Geometry, Trigonometry, Mathematical analysis, Classic mechanics, Equations of mathematical physics, Electricity
4.2. competencies	Knowledge of the trigonometrical functions and relations. Knowledge and use of the harmonic oscillator equations and the mechanical waves equations. Capability of mathematical (computational) modelling of oscillating phenomenon.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia equipped class (videoprojector) Lecture notes Recommended bibliography
5.2. for practicals/tutorials/projects	

	Laboratory of optics with experimental works of geometrical optics, photometry, interference, diffraction, polarization, thermal radiation.

6. Specific competences acquired

Professional competencies	C1 - Identification and appropriate use of main laws and principles of physics in a given context. C3 - Solving problems of physics in imposed conditions, using numerical and statistical methods C4 – Applying knowledges from the field of physics both in concrete situations from related fields, as well as in some experiments, using the standard laboratory equipment. C5 - Communication and analysis of information with didactic, scientific and popularization character in the field of Physics.
Transversal competencies	CT1 – Achievement of professional tasks in efficient and responsible way with the compliance of ethics legislation specific to the field, under qualified assistance. CT2 - Application of efficient working techniques in multidisciplinary team on different hierarchical levels. CT3 - Efficient use of information sources and of resources of communication and formation in a foreign language.

7. Course objectives

7.1. General objective	Knowing the laws and principles of light propagation, notions of geometrical optics image formation and understanding of optical instruments. Knowledge of fundamental phenomena in physical optics (wave-particle duality, interference, diffraction, polarization, emission and light detection) and understanding the functioning of simple optical devices based on these phenomena.
7.2. Specific objectives	Objective 1: Fundamental knowledge. Students will be competent in physical phenomena, mathematics and computing applications from physical optics, such that to allow them to approach optics problems from conceptual, analitical, numerical, and experimental point of view. Objective 2: Applicative. Students will gain skills related to optical techniques and an understanding of abilities necessary to adapt at the scientifical challenges of the future. Objective 3: Design and development. Students will be capable to solve problems of optics in a multidisciplinary environment, of team. Objective 4: Communication. Students will be capable to communicate scientific information orally, written and in graphic form. Objective 5: Behavioral. Students will act ethical and will appreciate the impact of optics on society, economy and environment.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Evolution of optics knowledge. Induction and deduction in knowledge. FOUNDAMENTALS OF GEOMETRICAL OPTICS - Eikonal equation; Lagrange's integral invariant; The principle of Fermat; LAGRANGIAN FORMULATION OF OPTICS - Ray equation	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples.	3 hours
LAWS AND PRINCIPLES OF GEOMETRICAL OPTICS - Law of reflection; Law of refraction; Total reflection; Laws and principles of geometrical optics APPLICATIONS OF TOTAL REFLECTION - Evanescent waves; Guided waves, optical waveguide, end coupling, guided modes; Total reflection prisms	Systematic exposition - lecture. Heuristic conversation. Experiment. Examples.	3 hours
LIGHT RAYS AND IMAGINES - Graphical ray-trace method; PLANE SURFACES - Plane mirror; Plane-parallel plate; Prism SPHERICAL SURFACES- Parabolic mirrors; Spherical mirrors; Mirror aberrations; Spherical transmission surfaces (diopters)	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples.	3 hours

THIN LENSES - Types of lenses; Graphical ray-trace method; Lens makers' formula; Conjugate point formula; Cardinal points LINEAR SISTEMS- Point Spread Function; Optical Transfer Function	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples.	3 hours
OPTICAL ABERRATIONS - Geometric aberrations of point images MATRIX FORMULATION OF GEOMETRICAL OPTICS - Basic formula; Spherical surfaces; Thick lens; Optical systems	Systematic exposition - lecture. Heuristic conversation. Examples.	3 hours
IDEAL OPTICAL SYSTEMS - Fundamental relations for ideal systems OPTICAL INSTRUMENTS - Basic characteristics; Fundamental optical instruments: Magnifying glass: Optical microscope; Refracting telescope; Photo camera; Human eye	Systematic exposition - lecture. Heuristic conversation. Examples.	3 hours
PHOTOMETRY- Physical quantities, measurements and units of measure; Reflection, transmission and absorption coefficients. COLORIMETRY - CIE standard; Additive color model; Subtractive color model; Color space, additive color mixing	Systematic exposition - lecture. Examples.	3 hours
Light as electromagnetic wave. Maxwell equations in optical media. Wave equation. Plane waves and spherical waves.	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Case studies. Examples	2 hours
Phase speed and group speed. Rayleigh relation. Theory of light dispersion. Complex refractive index. Optical constants (refractive index and extinction coefficient).	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Case studies. Examples	2 hours
Light interference. Coherent waves. Young double slit experiment. Interfringe calculus. Interference in white light. Interference by wave-front division. Young-Fresnel devices.	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Examples	2 hours
Interference by amplitude division. Interference devices. Fringes classification (equal thickness, equal inclination). Newton rings. Two beams interferometry. Michelson interferometer.	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Examples	3 hours
Light diffraction. Fresnel diffraction (divergent light). Fresnel zones. Fraunhofer diffraction (parallel light) on filiform slit, circular slit, double slit and plane diffraction gratings. Resolution of optical instruments (Abbe's relation).	Systematic exposition - lecture. Heuristic conversation. Critical analyzes. Examples	5 hours
Light polarization. Light polarization by reflection and refraction. Malus and Brewster experiments. Light polarization by double refraction (birefringence). Polarizing prisms. Light polarization by dichroism and light scattering.	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Critical analyzes. Examples	3 hours
Elliptically polarized light (interference in polarized light). Artificial birefringence. Optical activity (rotatory polarization) in optical media (solids and liquids). Light propagation in isotropic media. Fresnel relations.	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Critical analyzes. Examples	3 hours
Thermal radiation. Photometric study of black-body as a Lambert surface. Deduction of Wien displacement law and Stefan- Boltzmann law.	Systematic exposition - lecture. Heuristic conversation. Modelling (TIC). Critical analyzes. Examples	1 hour

Bibliography:
Geometrical Optics, Mircea Bulinski , Editura Universitatii Bucuresti (2014);
I.I. Popescu, "Optica geometrica" Vol. I Tipografia Universitatii din Bucuresti (1988). St.Levai, M.Bulinski, O.Toma, "Optica", Editura Universitatii din Bucuresti (2005)
Iulian Ionita – Optica ondulatorie, http://www.fizica.unibuc.ro/Fizica/Studenti/Cursuri/Main.php-

F. Pedrotti, L. Pedrotti, Introduction to Optics, Prentice Hall, New Jersey, 1993 E. Hecht, Optics, Addison-Wesley, 2002 M. Born, E.Wolf, "Principles of Optics", Cambridge University Press (1998) M. Giurgea, L.Nasta, Optica Editura Academiei Române, Bucuresti, 1998. G. Brătescu, Optica, Editura Didactica şi Pedagogica, Bucuresti, 1982 I. Iova, Elemente de optica aplicata, Editura stiintifica si enciclopedica, Bucureşti, 1977

8.2. Tutorials	Teaching and learning techniques	Observations
Centered optical systems. Exercises and problems.	Tutorials	3 hours
Photometry and radiometry. Exercises and problems.	Tutorials	2 hours
Optical instruments. Exercises and problems.	Tutorials	2 hours
Interference of light. Exercises and problems.	Tutorials	3 hours
Diffraction of light. Exercises and problems.	Tutorials	2 hours
Polarization of light. Exercises and problems.	Tutorials	2 hours

Bibliography: Ovidiu Toma, Doina Bejan, Marian Băzăvan, Iulian Ioniță, Mircea Bulinski, „Geometrical Optics, Practical Works, Exercises and Problems" Editura Universitatii Bucuresti (2021); D.Bejan, M.Bazavan, I.Ionita, O.Toma, M.Bulinski, I.Gruia, "Lucrari practice de optica geometrica", Editura Universitatii din Bucuresti (2013). D Bejan, M. Bazavan, I. Ionita, O. Toma - Lucrari Practice de Optica Ondulatorie, Ed. Unibuc. Buc, Bucuresti, 2013. St.Levai, A.Ioan, L.Nasta, Optica. Exercitii si probleme, Tipografia Universitatii din Bucuresti (1984)

8.3. Practicals	Teaching and learning techniques	Observations
Reflection and refraction laws.	Guided practical activity	2 hours
Measurement of focal distance at converging lenses, diverging lense and concave mirrors.	Guided practical activity	4 hours
The determination of cardinal elements of centered optical systems.	Guided practical activity	2 hours
Spherical aberration. Measurement of focal distance at a lens with high convergence.	Guided practical activity	2 hours
The study of optical prism; measurement of refractive index by minimum deviation method.	Guided practical activity	2 hours
Measurement of the refractive index at liquids with Abbe refractometer.	Guided practical activity	2 hours
Laws of photometry. Measurement of integral light flux of a light source using Ulbricht integrating sphere.	Guided practical activity	3 hours
Determination of transmission curve with Pulfrich spectrophotometer.	Guided practical activity	2 hours
Optical microscope – measurement of angular Magnification (grosisment). Refracting telescope – measurement of grosisment.	Guided practical activity	2 hours
Interference of light. Young-Fresnel devices (Billet double-lens, Fresnel biprism).	Guided practical activity	3 hours
Michelson interferometer.	Guided practical activity	2 hours
Diffraction on filiform slit. Experimental verification of Fraunhofer intensity distribution.	Guided practical activity	2 hours
Plane diffraction grating. Determining the grating's frequency.	Guided practical activity	2 hours
Malus law. Determination of the polarization degree at a laser diode.	Guided practical activity	2 hours
The study of rotatory polarization at solids.	Guided practical activity	2 hours
The study of rotatory polarization at liquids. Laurent polarimeter.	Guided practical activity	2 hours
Thermal radiation; Stefan-Boltzmann law.	Guided practical activity	2 hours
Thermal radiation; Wien's displacement law.	Guided practical activity	2 hours
The study of optical detectors. Determination of spectral sensitivity.	Guided practical activity	2 hours

Bibliography: Ovidiu Toma, Doina Bejan, Marian Băzăvan, Iulian Ioniță, Mircea Bulinski, „Geometrical Optics, Practical Works,

Exercises and Problems” Editura Universitatii Bucuresti (2021); D.Bejan, M.Bazavan, I.Ionita, O.Toma, M.Bulinski, I.Gruia, “Lucrari practice de optica geometrica”, Editura Universitatii din Bucuresti (2013). D Bejan, M. Bazavan, I. Ionita, O. Toma - Lucrari Practice de Optica Ondulatorie, Ed. Unibuc. Buc, Bucuresti, 2013. St.Levai, A.Ioan, L.Nasta, Optica. Exercitii si probleme, Tipografia Universitatii din Bucuresti (1984)		
8.4. Project	Teaching and learning techniques	Observations
Bibliography: -		

9. 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)

he discipline content is based on a tradition of over 150 years of teaching Optics at University of Bucharest, improved and correlated with todays directions of development in optics as presented in the papers and conferences of international societies OSA and SPIE. 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 (Rochester Institute of Optics, Rochester University). The contents are in line with the requirements/expectations of the main employers of the graduates (industry, research, secondary school teaching – INFLPR, INFM, INOE, IOR as the main employers of our graduates with competences in Optics).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	▪ - coherence and clarity of exposition ▪ correct use of equations/mathematical methods/physical models and theories ▪ ability to indicate/analyse specific examples	Final written evaluation: Test of theoretical knowledges and applied problems.	50%
		Continue evaluation	20%
		Attendance	10%
10.5.1. Tutorial	X	X	X
10.5.2. Practical	- Applying specific methods of solving the given problem; - Results interpretation;	Evaluation by practical test	20%
10.5.3. Project			
10.6. Minimal requirements for passing the exam • Mandatory attendance: 50% from lectures and all practicals completed. • At least mark 5 at the end of evaluation.			

Date 2.11.2021	Teacher’s name and signature Conf. Dr. Mircea BULINSKI Lect. Dr. Ing. Ovidiu TOMA	Practicals/Tutorials instructor(s) name(s) and signature(s) Conf. Dr. Mircea BULINSKI Lect. Dr. Ing. Ovidiu TOMA
Date of approval 11.11.2021		Head of Department Lect.dr. Roxana ZUS

DI.202F.EN Analytical Mechanics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Theoretical Physics, Mathematics, Optics, Plasma, Lasers

1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Analytical Mechanics							
2.2. Teacher				Associate prof. dr. Iulia Ghiu				
2.3. Tutorials/Practicals instructor(s)				Teaching assist. dr. Andreea Croitoru				
2.4. Year of study	2	2.5. Semester	3	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	2	Practicals		Project	
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	28	Practicals		Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	20
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	25
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	69
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Mechanics, Electricity and magnetism, Algebra, Real and complex analysis, Equations of mathematical physics
4.2. competencies	A good level of algebra, geometry, trigonometry, real and complex analysis

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (video projector, PC).
5.2. for practicals/tutorials/projects	Video projector

6. Specific competences acquired

Professional competencies	Using the law of physics in a proper way for a given problem. To be able to communicate and analyze the information from the lectures, from the scientific literature, as well as the information for popularization of physics.
Transversal competencies	Using in an efficient way the informational and communication resources in a foreign language.

7. Course objectives

7.1. General objective	Understanding the concepts of analytical mechanics, developing the ability of solving problems of analytical mechanics.
7.2. Specific objectives	Developing the ability of applying the Lagrangian and Hamiltonian formalisms in order to solve complex problems of analytical mechanics.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Constraints. The d'Alembert principle. Generalized forces	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
Lagrange equations. Lagrange equations for systems with potential applied forces. The Lagrange function. The analytic structure of the kinetic energy. Generalized momenta and cyclic coordinates. Conservation of energy	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	4 h
Modification of the Lagrange function leaving the Lagrange equations unchanged. Plane pendulum: the Lagrange function, the Lagrange equation, the tension force in the cord, the period of oscillation	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	3 h
Equilibrium configuration. Small oscillations: Lagrange equations, normal frequencies	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	3 h
Hamilton's principle. The equivalence of Hamilton's principle with Lagrange's equations	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
The Hamilton function. Hamilton equations. Modification of the Hamilton function induced by a physically irrelevant change of the Lagrange function. Variation of a dynamical variable. The Poisson bracket	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
Properties of the Poisson brackets. The fundamental Poisson brackets. Poisson's theorem. The Hamilton function expressed using the spherical coordinates	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
The electromagnetic potentials. The Lorentz force expressed in terms of the electromagnetic potentials	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
The Lagrange function for a charged particle in an electromagnetic field. The Hamilton function for a charged particle in an electromagnetic field. Modification of the Lagrange function and Hamilton function induced by a gauge transformation	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
Two-body problem. Central field of force: general feature of the trajectory. Central field: the Lagrange function. Conservation laws	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
The radial equation. The Binet's equation. The effective potential energy of a particle in a repulsive Coulomb field. The effective potential energy of a particle in an attractive Coulomb field. The equation of the trajectory for a particle in a Coulomb field. Analysis of the trajectory. The study of the elliptic motion of a particle in a Coulomb field	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	4 h
Bibliography: 1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, 3rd Edition, Addison-Wesley, 2001. 2. I. Merches , L. Burlacu, Applied analytical mechanics, "The Voice of Bucovina" Press, 1995. 3. T. Kibble, F. Berkshire, Classical Mechanics, 5th Edition, Imperial College Press, 2004. 4. F. D. Aaron, Mecanica analitica, Editura BIC ALL, 2002.		
8.2. Tutorials	Teaching and learning techniques	Observations
Lagrange formalism	Problem solving. Guided work	8 h
Small oscillations	Problem solving. Guided work	4 h
Hamilton formalism	Problem solving. Guided work	8 h
The motion of a particle in a central field	Problem solving. Guided work	8 h
Bibliography: 1. I. Merches , L. Burlacu, Applied analytical mechanics, "The Voice of Bucovina" Press, 1995. 2. L. Burlacu, D. David, Probleme de mecanica analitica, Editura Universitatii din Bucuresti, 1988.		
8.3. Practicals	Teaching and learning techniques	Observations

Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Understanding the basic concepts of Analytical Mechanics - Correct use of equations and physical models	Written examination	90 %
10.5.1. Tutorial	- Ability of solving problems of Analytical Mechanics	Homeworks	10 %
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam For getting the mark 5: Attending minimum 50 % of the lectures and 75 % of the tutorials. Minimum 50 % of the requirements for the final mark.			

Date 5.11.2021	Teacher’s name and signature Associate prof. dr. Iulia Ghiu	Practicals/Tutorials instructor(s) name(s) and signature(s) Teaching assist. dr. Andreea Croitoru

Date of approval
11.11.2021

Head of Department
Lect. dr. Roxana Zus

DI.203F.EN Electrodynamics and Theory of Relativity I

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)

1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Electrodynamics and Theory of Relativity I								
2.2. Teacher				Conf.dr. Boca Madalina					
2.3. Tutorials/Practicals instructor(s)				Lect.dr. Baran V. Virgil					
2.4. Year of study	II	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DF	
							Type 2)	DI	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	2	Practicals		Project	
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	28	Practicals		Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	30
3.3.2. Research in library, study of electronic resources, field research	15
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	65
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Real and Complex Analysis , Algebra , Geometry and Differential Equations , Equations of Mathematical Physics , Electricity and Magnetism
4.2. competencies	Knowledge about : - Phenomenological basics of electromagnetism - Differential and integral calculus, partial differential equations, special functions, orthogonal polynomials

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia equipped class (videoprojector), internet connection Lecture notes Recommended bibliography
5.2. for practicals/tutorials/projects	Multimedia equipped class (videoprojector), internet connection Lecture notes Recommended bibliography

6. Specific competences acquired

Professional competencies	- Identification and appropriate use of main laws and principles of physics in a given context. - Solving problems of physics in imposed conditions, using numerical and statistical methods – Applying knowledge from the field of physics both in concrete situations from related fields, as well as in some experiments, using the standard laboratory equipment. - Communication and analysis of information with didactic, scientific and popularization character in the field of Physics - Interdisciplinary approach of some physics topics
Transversal competencies	– Achievement of professional tasks in efficient and responsible way with the compliance of ethics legislation specific to the field, under qualified assistance. - Efficient use of information sources and of resources of communication and formation in a foreign language.

7. Course objectives

7.1. General objective	-Understanding the fundamental aspects related to the study of the electromagnetic field both in stationary and variable cases, based on the laws of electromagnetism. Training capacities to approach and solve specific problems . -Acquiring knowledge concerning the various applications of the theory of electromagnetic field. Training capacities to approach and solve specific problems.
7.2. Specific objectives	- Acquiring knowledge of specific physical theories/models - Developing the ability to work in a team - Understanding of the fundamental laws of electromagnetism, conservation laws of electric charge, electromagnetic energy and momentum, of the concept of electromagnetic potential, of the multipole fields. - Understanding the influence of matter on the electromagnetic field. -Acquiring the skills to describe and calculate the electromagnetic field of various systems of charges and currents, by use of specific mathematical techniques. -Understanding the concept of electromagnetic radiation and acquiring the support knowledge for describing and calculating the electromagnetic field radiated by specific systems. Acquiring the skills to describe various types of radiative systems (antennas). -Understanding the propagation of the electromagnetic field as waves, their specific physical quantities, the polarization, reflection and refraction of waves. Understanding and study of optical phenomena on the basis of electromagnetic laws.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Electric field of volume charge distributions. The Poisson equation for the electric potential. Green's Theorem. The boundary value problems for the Poisson equation; Dirichlet and Neumann boundary conditions. The uniqueness theorem. General methods for solving the Poisson equation. Conservation of the electric charge; continuity equation.	Systematic exposition - lecture. Examples	5
The magnetic field of current distributions. The equations of the magnetic field in vacuum in the stationary regime. Volume distribution of currents. Integral representation of the vector potential.	Systematic exposition - lecture. Examples	2
The fundamental laws of electromagnetism. Generalization of the equations of the stationary field to the time-dependent case. The Maxwell equations for the electromagnetic field in vacuum. The local and integral form of electromagnetism lows.	Systematic exposition - lecture. Examples	2
Electrodynamics potentials. Gauge transformations, equations of the potentials, retarded and advanced potentials.	Systematic exposition - lecture. Examples	2
General theorems of the electromagnetic field. Theorem of the energy of the electromagnetic field in vacuum (Poynting). Theorems of the kinetic and angular momentum of the electromagnetic field in vacuum.	Systematic exposition - lecture. Examples	3
Multipole analysis of the electromagnetic field. Multipole expansion of retarded potentials. Electric and magnetic multipoles. Averaging of the microscopic electromagnetic field equations. Maxwell's equations in polarizable / magnetizable media. P, D, M, H, vectors. The discontinuity of the electromagnetic field at the interface between two different media. Energy, force and torque exerted by an external field on a localized system of charges and currents.	Systematic exposition - lecture. Examples	7

Radiation of localized systems of charges and currents. The field and radiation of simple charge and current distributions. Dipole approximation. Types of antennas.	Systematic exposition - lecture. Examples	2
Propagation of the electromagnetic field. Properties of plane electromagnetic waves; the monochromatic case (phase, wavelength, frequency, polarization). The laws of reflection and refraction. Snell's law. Total internal reflection. Fresnel's relations for an arbitrary angle. Polarization by reflection. Reflection and transmission coefficients.	Systematic exposition - lecture. Examples	5

Bibliography:

W.K.H. Panofski, M. Phillips, *Classical Electricity and Magnetism* , 2-nd ed. , AddisonWesley, Reading, Mass., 1962
R.M. Fano, L.J.Chu, R.B.Adler, *Electromagnetic Fields, Energy and Forces*, John Wiley&Sons, 1963
R. Becker, *Electromagnetic Fields and Interactions*, Dover Publications, 1982
H. C. Ohanian , *Classical Electrodynamics*, 1988, Allyn and Bacon, 1988
O.D. Jefimenko, *Electricity and Magnetism: An Introduction to the Theory of Electric and Magnetic Fields,* ed.2, Appleton-Century-Crofts, 1989
C. Vrejoiu, *Electrodinamica si teoria relativitatii* , Editura didactica si pedagogica, Bucuresti,1993
W. Greiner, *Classical Electrodynamics*, Springer Verlag, 1998
J. Schwinger, L. DeRaad jr., K.A. Milton, Wu-Yang Tsai, *Classical electrodynamics,* Perseus Books, 1998
J . D . Jackson, *Classical electrodynamics* , 3-rd ed. , John Wiley & Sons , 1998
F. Melia, *Electrodynamics*, University of Chicago Press, 2001
L . D . Landau, E .M. Lifshitz, *The Classical Theory of Fields*, ed. 4, Butterworth, -Heinemann, 2003
F.E. Low, *Classical Field Theory*. Electromagnetism and Gravitation Wiley-VCH Verlag 2004
D.J. Griffiths, *Introduction to Electrodynamics*, 4-th ed., Pearson, 2013
Wolfgang Nolting, *Theoretical Physics 3: Electrodynamics,* Springer;. 2016
C. Stoica, *Note de curs,in format electronic*, pe site-ul departamentului.

8.2. Tutorials	Teaching and learning techniques	Observations
Elements of field theory and vector and differential calculus (grad, div, rot and curl). Curvilinear orthogonal coordinates. Differential operators in curvilinear coordinates (spherical, cylindrical, polar).	Problem solving. Guided work. Case study. Examples.	4 h
Point-like, linear, surface charge distributions written as generalized volume densities. The Dirac distribution and its properties.	Problem solving. Guided work. Case study. Examples.	2 h
Calculation of the electric potențial in the presence of a conductor using the expansion of the solution in the basis of complete sets of special functions and orthogonal polynomials. Spherical functions, Legendre polynomials, Bessel functions. The solutions of the Sturm Liouville problem for the Legendre and Bessel equations. Completeness, orthogonality, integral representations, generating functions, recurrence relations. Green function method.	Problem solving. Guided work. Case study. Examples.	5 h
Multipole expansion of the electric and magnetic potential. Electric and magnetic multipoles. The energy, force and torque exerted by an external field on multipole systems. Spherical multipoles.	Problem solving. Guided work. Case study. Examples.	3 h
Computation of the magnetic field of given current distributions using the method of the scalar and vector potential. The magnetic field of linear, surface and volume current distributions (in the volume and on the surface of a sphere/cylinder).	Problem solving. Guided work. Case study. Examples.	4 h
Conservation laws in electrodynamics. Computation of the energy, momentum and angular momentum of various electromagnetic field configurations with spherical, planar and cylindrical symmetries in vacuum.	Problem solving. Guided work. Case study. Examples.	2 h
Electrostatic problems with dielectric bodies.	Problem solving. Guided work.	4 h

Polarization of a spherical dielectric in an external homogeneous field or in the field of a point-like charge. Polarization surface charge. A point-like electric charge near the plane interface of two adjacent dielectrics. Screening of the electric and magnetic field by a dielectric. Spherical screen.	Case study. Examples.	
The dipole radiation. Linear and circular antenna. The radiation field, angular distribution and total radiated power. Polarization of the radiated field.	Problem solving. Guided work. Case study. Examples.	2 h
Study of the properties of the monochromatic waves. Polarization. Stokes parameters	Problem solving. Guided work. Case study. Examples.	2 h

Bibliography:

V. Novacu, *Culegere de probleme de electrodinamica*, Editura tehnica , Bucuresti , 1964
V.V. Batygine, I.N. Toptygine, D. TerHaar, *Problems in Electrodynamics* , Ed.2, Academic Press , 1978
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C. Brau, *Modern Problems in Classical Electrodynamics*, Oxford University Press, 2004
Lim Yung-kuo (ed.), *Problems and Solutions on Electromagnetism*, World Scientific, 2005
Syed A. Nasar *2008+ Solved Problems In Electromagnetics* Sci Tech Publishing 2007
J. Pierrus, *Solved Problems in Classical Electromagnetism: Analytical and Numerical Solutions with Comments*, Oxford University Press; Illustrated edition (September 19, 2018)

8.3. Practicals	Teaching and learning techniques	Observations

Bibliography:

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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 and abilities which are fundamental for an undergraduate student in the field of modern physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, academic, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition -correct use of equations / mathematical methods / physical models and theories - ability to indicate / analyse specific examples	Written test / oral examination	60%
10.5.1. Tutorial	-ability to use specific problem solving methods - ability to analyse the results	Homeworks/written tests	40%
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam			

Attendance score of minimum 50% of Lectures and all Tutorial classes. At least 50% of exam score and 50% of total score in the final examination.

Date 5.11.2021	Teacher’s name and signature Madalina Boca	Practicals/Tutorials instructor(s) name(s) and signature(s) Virgil V. Baran

Date of approval 11.11.2021	Head of Department Lect.dr. Roxana Zus

DI.204F.EN Fundamentals of Atomic Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics,Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Fundamentals of Atomic Physics								
2.2. Teacher				Conf.dr. Vasile Bercu					
2.3. Tutorials/Practicals instructor(s)				Conf.dr. Vasile Bercu					
2.4. Year of study	2	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Classification of course unit		Content [1]	DF
								Type [2]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	1	Practicals	1	Project	-
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	14	Practicals	14	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	15
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	30
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	65
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Classical Mechanics I,II; Molecular Physics and Heat I, II; Electricity and magnetism; Real analysis; Optics
4.2. competencies	Knowledge of mathematics, classical mechanics, molecular physics and heat

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphitheater equipped with multimedia devices (video)
5.2. for practicals/tutorials/projects	Laboratory with experimental set up for atomic experiments Computers

6. Specific competences acquired

Professional competencies	C1: Identification and appropriate use of main physical laws and principles in a given context. C2: Use of software for analysis and data processing. C3: Troubleshooting the physical conditions required using numerical and statistical methods C4: Applying knowledge in the field of physics both in concrete situations from related fields as well as in experiments, using standard laboratory equipment C5: Communication and analysis of didactic, scientific and dissemination of information C6: Interdisciplinary approach to physics topics.
Transversal competencies	CT1- Achievement of the professional duties in an efficient and responsible way with compliance with deontological legislation specific to the domain under qualified assistance. CT3: Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	Assimilation of theoretical and experimental foundations of phenomena related to the fundamentals of atomic physics
7.2. Specific objectives	Familiarization with the fundamental concepts and models in the field of atomic physics; Acquiring scientific methods of analysis; Description and understanding of mathematical methods associated with the field of atomic physics; Developing the ability to quantitatively analyze specific cases and to interpret the fundamental phenomena in the field; Development of the ability to apply appropriate numerical models for modeling phenomena from the atomic level; Development of experimental skills and acquisition of the main principles used in atomic physics.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
The electron - deviation in magnetic and electric field of electrons and ion beans - the parabolic method - the specific charge - the variation of electron mass with velocity - the classical radius of electron	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
Thermal radiation and the hypothesis of quantum energy - the black body radiation(the Wien and Stefan–Boltzmann radiation laws) - the Rayleigh-Jeans law – „the ultraviolet catastrophe" - The Planck radiation law	Systematic exposition - lecture. Critical analysis.	4 hours
The corpuscular proprieties of radiation - photoelectric effect - Compton effect - continuum spectra of X ray	Systematic exposition -lecture. Heuristic conversation.	3 hours
The wavelike behavior of particles - de Broglie iphothesis - electron diffraction - wave–particle duality: the wave packet	Systematic exposition -lecture. Heuristic conversation.	3 hours
The atomic structure - scattering cross section - the Rutherford experiment - alpha particle in nuclear field	Systematic exposition - lecture.Examples.	4 hours
Atomic models - Thomson model - Rutherford model - Bohr model - Bohr-Sommerfeld model	Systematic exposition - lecture. Heuristic conversation.	4 hours

Atoms in magnetic fields - Stern-Gerlach experiment - orbital magnetic moment - the electron spin - the Zeeman effect	Systematic exposition - lecture. Heuristic conversation.	4 hours
Spin-orbit interaction The vector model of atom	Systematic exposition - lecture. Heuristic conversation.	4 hours
Bibliography: - Fizica atomica: note de curs, Florin Popescu si Florin Marica ; Ars Docendi, 1998 -Fizica atomului si a moleculei B. H. Bransden si C. J. Joachain, Bucuresti, 1998 - Fizica atomică - Vol I, V. Spolschi, Editura Tehnica, 1953 - Atkins' physical chemistry - Peter Atkins, Julio de Paula, Oxford University Press, 2010 - Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics -Wolfgang Demtröder Springer; 2nd ed. 2010 - Quantum physics of atoms, molecules, solids, nuclei and particlesRobert Martin Eisberg and Robert Resnick, New York ; John Wiley & Sons, 1974 - The physics of atoms and quanta : introduction to experiments and theory Haken, Hermann Wolf, Hans Christoph Berlin; Springer, 1994		
8.2. Tutorials	Teaching and learning techniques	Observations
The laws of black body radiation. Problems	Example. Problems. Guided work	2 hours
Photon - the corpuscular character of radiation. Problems	Example. Problems. Guided work	2 hours
Electron diffraction – undulating the wavelike behavior of particles and the wave–particle duality. Problems	Example. Problems. Guided work	2 hours
The gamma-rays spectroscopy: photon-crystal interaction, the photomultiplier principles. Processing signals generated by gamma photons: the amplitude spectrum, calibration and determination of photon energy.	Example. Problems. Guided work	2 hours
The structure of atoms. Problems	Example. Problems. Guided work	2 hours
The atomic models. Problems	Example. Problems. Guided work	2 hours
Atoms in the magnetic field. Problems	Example. Problems. Guided work	2 hours
Bibliography: - Fizica atomica: note de curs, Florin Popescu si Florin Marica ; Ars Docendi, 1998 -Fizica atomului si a moleculei B. H. Bransden si C. J. Joachain, Bucuresti, 1998 - Fizica atomică - Vol I, V. Spolschi, Editura Tehnica, 1953 - Atkins' physical chemistry - Peter Atkins, Julio de Paula, Oxford University Press, 2010 - Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics -Wolfgang Demtröder Springer; 2nd ed. 2010 - Quantum physics of atoms, molecules, solids, nuclei and particlesRobert Martin Eisberg and Robert Resnick, New York ; John Wiley & Sons, 1974 - The physics of atoms and quanta : introduction to experiments and theory Haken, Hermann Wolf, Hans Christoph Berlin; Springer, 1994		
8.3. PracticalsDetermination of the specific charge of the electron	Teaching and learning techniques	Observations
Determination of the specific charge of the electron	Guided practical activities	2 hours
Determination of Planck’s constant using the photoelectric effect	Guided practical activities	2 hours
Continuous spectra emitted by the X-ray tube. Determination of Planck’s constant.	Guided practical activities	2 hours
The Millikan experiment – determination of the elementary charge	Guided practical activities	2 hours
The Compton effect	Guided practical activities	2 hours

The electron diffraction	Guided practical activities	2 hours
Balmer series. Determination of Rydberg's constant.	Guided practical activities	2 hours
Bibliography: - Fizica atomica : lucrari practice , colectiv de autori: Elena Borca, et al.Tipografia Universitatii din Bucuresti, 1984 - Lucrari practice de fizica atomica, care se gasesc pe site-ul : htttp://brahms.fizica.unibuc.ro/atom/atom/LabAtom.php - Fizica atomica: note de curs, Florin Popescu si Florin Marica ; Ars Docendi, 1998 -Fizica atomului si a moleculei B. H. Bransden si C. J. Joachain, Bucuresti, 1998 - Fizica atomică - Vol I, V. Spolschi, Editura Tehnica, 1953 - Atkins' physical chemistry - Peter Atkins, Julio de Paula, Oxford University Press, 2010 - Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics -Wolfgang Demtröder Springer; 2nd ed. 2010 - Quantum physics of atoms, molecules, solids, nuclei and particlesRobert Martin Eisberg and Robert Resnick, New York ; John Wiley & Sons, 1974 - The physics of atoms and quanta : introduction to experiments and theory Haken, Hermann Wolf, Hans Christoph Berlin; Springer, 1994		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 forms/develops some theoretical and/or practical competences and abilities which are fundamental for an undergraduate student in the field of modern Physics, corresponding to national and European/international standards. 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.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/ mathematical methods/physical models and theories - ability to indicate/analyses specific examples - ability to solve course-specific practical problems	Continuous Evaluation a) Partial examination of theoretical knowledge: written and oral b) Answers and activity during the lectures c) Final examination of theoretical knowledge: written and oral For online assessment, the subjects will be electronically sent via Google Classroom / Microsoft Teams, and during the exam students will have their video camera turned on, the exam being recorded.	30% 5% 30%
10.5.1. Tutorial	- ability to use specific problem solving methods - ability to analyses the results	Homework and answers during the tutorials	10 %
10.5.2. Practical	- ability to use specific experimental methods/apparatus	Colloquium examination	25%

	- ability to perform/design specific experiments - ability to present and discuss the results		
10.5.3. Project			

10.6. Minimal requirements for passing the exam Attendance at least 50% of the number of class hours and compulsory attendance at all laboratory and tutorials meetings. To obtain minimum the mark 5 from evaluation criteria. Requirements for mark 5 (10 points scale) Know the notions related to the black body, deducing Planck's relationship and solving specific problems. Correct understanding of the notions related to the corpuscular character of radiation: photoelectric effect, Compton effect, and solving specific problems. Correct understanding of the notions related to the wave like nature of matter: de Broglie's hypothesis, electron diffraction, and solving specific problems. Correct understanding of the notions related to wave-corpuscle duality and the use of wave packets Know how to calculate different sizes characteristic of atoms using atomic models Correct understanding of the notions related to the magnetic properties of atoms. Know how to use the basics of the course content in simple applications.

Date
4.11.2021

Teacher’s name and signature
Conf. dr. Vasile Bercu

Practicals/Tutorials instructor(s) name(s) and signature(s)
Conf.dr. Vasile Bercu

Date of approval
11.11.2021

Head of Department
Prof.dr. Alexandru Jipa

DI.206F.EN Scientific English III

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Foreign Languages and Literatures
1.3. Department	Department of Modern Languages
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Scientific English III							
2.2. Teacher			Lecturer Monica Oanca, PhD					
2.3. Tutorials/Practicals instructor(s)			-					
2.4. Year of study	II	2.5. Semester	I	2.6. Type of evaluation	C	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	-	Tutorials	1	Practicals	-	Project	-
3.2. Total hours per semester	14	distribution:	Lectures	-	Tutorials	14	Practicals	-	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	2
3.3.2. Research in library, study of electronic resources, field research	3
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	2
3.3.4. Examination	4

3.3.5. Other activities			-
3.4. Total hours of individual study	7		
3.5. Total hours per semester	25		
3.6. ECTS	1		

4. Prerequisites (if necessary)

4.1. curriculum	A good command of English – level B2
4.2. competencies	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	-
5.2. for tutorials/projects	If the seminar takes place in a classroom, a blackboard and a video projector are required The seminar can be held online, and each student is responsible for making sure that he/she has a microphone. It is advisable to turn the camera on during the seminar.

6. Specific competences acquired

Professional competencies	1. Defining and describing the main notions of grammar and vocabulary 2. Defining the five specific competencies: Understand a written text Understanding a listened message Conducting a conversation Delivering an oral presentation of a topic Writing compositions
Transversal competencies	1. Develop the reading skills in English to read texts needed for Physics classes and seminars 2. Writing a project on a physics topic that will be presented orally in front of the classmates 3. Write an essay on a Physics related topic

7. Course objectives

7.1. General objective	Understanding and using the specialized vocabulary necessary for reading texts and then elaborating essays on Physics related topics.
7.2. Specific objectives	1. Knowledge and understanding (knowledge and proper use of vocabulary related to Physics) Revise general knowledge of English and apply it to comprehension in Physics-related texts as mentioned in the seminar topics 2. Explanation and interpretation (explaining and interpreting some ideas, projects, processes, as well as the theoretical and practical contents of the discipline) Specialized expressions will be explained and commented upon; their use in the specific context of the English language will be emphasised. Some physics concepts will be translated and the difference between English and Romanian will be analysed. False friends, as well as structures that appear only in English will be mentioned. 3. Instrumental - applications (design, management and evaluation of specific practical activities; use of methods, techniques and tools for investigation and application). Students will use their computers to design PowerPoint presentations, as well as other tools to write their projects. 4. Attitudinal (manifestation of a positive and responsible attitude towards the scientific field / cultivation of a scientific environment focused on democratic values and relations / promotion of a system of cultural, moral and civic values / optimal and creative capitalization of one's own potential in activities) Students will develop the ability to use English texts for writing a seminar paper in English for one of the specialized seminars (in the field of physics). During the seminar the stress will be on originality and correct citation of sources. Students will be advised to assume their responsibility for their work and they will be taught to engage in various projects and in partnership with other specialists Teamwork – collaboration is encouraged, but provided that each participant has a well-defined contribution.

8. Contents

8.2. Tutorials	Teaching and learning techniques	Observations

▪ The World of Science ▪ Astronauts and Space stations ▪ Si-Fi films versus reality ▪ Writing a report ▪ Means of communication ▪ Mobile phones a benefit or social nuisance ▪ The Body clock ▪ Health and fitness ▪ Writing an opinion essay ▪ Decision-making skills ▪ Expressing opinions about the future ▪ Pieces of Career Advice ▪ Writing a letter of application 14. Students' projects	In all seminars students will interact with one another and will have to solve vocabulary exercises and repeat grammar structures. Texts related to the proposed topics will be discussed and comprehension exercises will be done. Conversations on these topics will be initiated, and listening exercises will be conducted, too. Students will give PowerPoint presentations on topics related to one of the subjects studied.	All seminars will use specialized texts written by native speakers (excerpts from books, magazines, etc.), vocabulary and grammar exercises, as well as recordings of native English speakers.

Bibliography:

McCarthy Michael, Felicity O' Dell, English Vocabulary in Use, (Upper Intermediate and Advanced), Cambridge University Press, 2002, 2005.
McCarthy Michael, Felicity O' Dell, Test your English Vocabulary in Use, (Upper Intermediate and Advanced), Cambridge University Press, 2002, 2005
Dearholt, Jim, Career Paths, Mechanics, Express Publishing, 2012
Virginia Evans, Jenny Dooley, Upstream Intermediate, Express Publishing, 2015.
Jan Bell Roger Gower, Advanced Expert , Coursebook, Pearson, 2017.
P. Frauenfelder and P. Huber, Introduction to Physics, Translated by F. S. Levin and J. L. Weil, Pergamon Press, 1978.

9. 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 seminars follow the format of the foreign language seminars within the University of Bucharest and are in accordance with the international standards regarding the level of linguistic competences.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.5.1. Tutorial	The ability to understand and use correctly the vocabulary discussed during the seminars	Evaluation by written tests Evaluation by oral tests portfolio	40% 40% 20%
10.6. Minimal requirements for passing the exam - correct acquisition of level B2 of English, - correct use of the main notions of grammar - correct use of specialized terms - solving all the classwork posted on Google Classroom			

Date 10.11.2021	Teacher's name and signature Lecturer Monica Oanca, PhD	Practicals/Tutorials instructor(s) name(s) and signature(s)

Date of approval
11.11.2021

Head of Department
Lect. univ. dr. Raluca Andreescu

DI.207F.EN Physical Education and Sport III

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	-
1.3. Department	Department of Physical Education and Sports
1.4. Field of study	Physics

1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Physical Education and Sport III							
2.2. Teacher								
2.3. Tutorials/Practicals instructor(s)				Lector univ dr.Cătălin Şerban				
2.4. Year of study	II	2.5. Semester	I	2.6. Type of evaluation	V	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	0	Tutorials	0	Practicals	0	Project	0
3.2. Total hours per semester	14	distribution:	Lectures	0	Tutorials	0	Practicals	14	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	0
3.3.2. Research in library, study of electronic resources, field research	0
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	0
3.3.4. Examination	4
3.3.5. Other activities	7

3.4. Total hours of individual study	7
3.5. Total hours per semester	25
3.6. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for practicals/tutorials/projects	

6. Specific competences acquired

Professional competencies	▪ Knowledge and understanding. -To acquire general knowledge about physical education and highlighting its specific content -To gain knowledge about the effects of motor activities on the body; To accumulate notions regarding the particularities of the physical education lesson at the level of non-profile higher education; -To apply the formative knowledge, in the field of physical education and sports, at the level of daily activities. ▪ Explanation and interpretation -To establish the objectives and tasks specific to the activities carried out; -To develop the capacity to practice systematic and independent physical exercises; -To capitalize on communication in sports as a way of social integration; -To develop the ability to understand, operate and expand motor activity in free time and recreation; -To develop the ability to capitalize on the positive effects of physical education on personality and quality of life; ▪ Instrumental – applications -To design and apply exercise programs adapted to the objectives of the activity carried out; -To coordinate, integrate and participate in sports activities; -To identify solutions regarding the optimization of free time; -To mobilize human resources in volunteer actions; -To know the evaluation methods specific to physical education.

Transversal competencies	-To integrate and participate in sports activities promoting the values of fair play; -To develop principled and constructive relationships with the social partners; -To adapt, in optimal conditions and in an efficient way, to new situations; -To develop pro-active attitudes, positive thinking and interpersonal relationships; - To be aware of the importance of exercising on maintaining an optimal state of health, increasing the body's endurance and increasing the capacity for physical and intellectual work.

7. Course objectives

7.1. General objective	To be aware of the importance of exercising on maintaining an optimal state of health, increasing the body's endurance and increasing the capacity for physical and intellectual work
7.2. Specific objectives	- Maintaining an optimal state of health of students and improving the resistance of their body to the action of environmental factors and the specifics of professional activity; - Ensuring superior indices of correct and harmonious physical development of the body; - Improving skills, motor skills and knowledge on the practice of a sport; - Cultivating the skills and habits of students to practice independently, in their free time, exercises and sports for corrective, fortifying, recreational or compensatory purposes; - Engaging the mass of students in the systematic activity of practicing physical exercises, tourism and sports; - Improving moral-volitional and intellectual qualities and traits, aesthetic sense and social responsibility

8. Contents

<table>
<tr><td>8.1. Lectures [chapters]</td><td>Teaching techniques</td><td>Observations</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Bibliography:</td></tr>
<tr><td>8.2. Tutorials</td><td>Teaching and learning techniques</td><td>Observations</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Bibliography:</td></tr>
<tr><td>8.3. Practicals
Numbei of hours -14</td><td>Teaching and learning techniques</td><td>Observations</td></tr>
<tr><td>Introductory lesson – 1h</td><td rowspan="6">Audiovisual techniques (Power Point presentation, teaching film presentation, audio material presentation)</td><td rowspan="6">Practical work</td></tr>
<tr><td>Initial verification -1h</td></tr>
<tr><td>Learning the basic technique – aerobic gymnastics and fitness – 3h</td></tr>
<tr><td>Learning the main tehnical elements with the ball (Basket-ball,football) – 4h</td></tr>
<tr><td>Acquiring yhe main collective tactical action of attack end defense (Basket-ball,football) – 3h</td></tr>
<tr><td>Intermediate verification- 2h</td></tr>
<tr><td colspan="3">Bibliography:
▪ Bibliografie Obligatorie:
▪ Ganciu, M., (coord), colectiv DEFS, 2013, Curs de educaţie fizică pentru studenţii Universităţii din Bucureşti, Editura Universităţii din Bucureşti, Bucureşti
▪ Ganciu, M., Aducovschi, D., Gozu, B., Stoica, A.M., Stoicoviciu, A., Gulap, M., Cristea, M., 2010, Activitatea fizică independentă şi valorificarea prin mişcare a timpului liber – Vol.I, Editura Universităţii din Bucureşti, Bucureşti
Stoica, A., 2011, Curs practic de gimnastică aerobică pentru studenții din Universitatea din București. Editura Universității din București
▪ Bibliografie facultativă:
▪ Colectivul DEFS, coord. Aducovschi D.,2008, Sistemul de evaluare la educație fizică – pe discipline sportive – în Universitatea din Bucuresti, Editura Universităţii din Bucureşti</td></tr>
</table>

▪ Colectivul DEFS, 2005, *Designul instrucţional în optimizarea instruirii echipelor reprezentative ale Universităţii din Bucureşti*, Editura Universităţii din Bucureşti C. Alte surse utile DVD-uri, internet

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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)

Physical education is a social activity with special contributions to the social-professional integration of young people. The formative function of physical education will contribute to the development of these qualities and abilities, which will allow the future specialist to acquire the chosen profession as quickly and better as possible, to practice it with high efficiency, to be able to engage in various social activities. to be able to act independently and creatively on the environment and on his own person.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture			
10.5.1. Tutorial			
10.5.2. Practical	- interest in the discipline through systematic - participation in practical lessons (1h / week)		60%
	- initial and intermediate testing by control tests and trials	individual assessment	30%
	- participation in sports competitions		10%
10.5.3. Project			
10.6. Minimal requirements for passing the exam • participation in 50% of the total number of lessons • passing motor tests • participation in a sports competition • to prove the minimum acquisition of the general notions of physical education and sports			

Date
10.11.2021

Teacher’s name and signature
Lector univ dr.Cătălin Șerban

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

Date of approval
11.11.2021

Head of Department
Prof. Stoica Alina, PhD

DI.203F.EN Electrodynamics and Theory of Relativity II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics

1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Electrodynamics and Theory of Relativity I							
2.2. Teacher				Conf.dr Boca Madalina				
2.3. Tutorials/Practicals instructor(s)				Lect.dr. Baran V. Virgil				
2.4. Year of study	II	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1]	DF
							Type [2]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	2	Practicals		Project	
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	28	Practicals		Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	25
3.3.2. Research in library, study of electronic resources, field research	5
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	10
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Real and Complex Analysis , Algebra , Geometry and Differential Equations , Equations of Mathematical Physics , Electricity and Magnetism, Electrodynamics and Theory of Relativity I
4.2. competencies	Knowledge about : - Phenomenological basics of electromagnetism - Differential and integral calculus, partial differential equations, special functions, orthogonal polynomials -Nonrelativistic kinematics and dynamics of particles. Analytical formalism of classical mechanics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia equipped class (video projector), internet connection Lecture notes Recommended bibliography
5.2. for practicals/tutorials/projects	Multimedia equipped class (video projector), internet connection Lecture notes Recommended bibliography

6. Specific competences acquired

Professional competencies	- Identification and appropriate use of main laws and principles of physics in a given context. - Solving problems of physics in imposed conditions, using numerical and statistical methods – Applying knowledge from the field of physics both in concrete situations from related fields, as well as in some experiments, using the standard laboratory equipment. - Communication and analysis of information with didactic, scientific and popularization character in the field of Physics - Interdisciplinary approach of some physics topics

Transversal competencies	– Achievement of professional tasks in an efficient and responsible way with the compliance of ethics legislation specific to the field, under qualified assistance. - Efficient use of information sources and of resources of communication and formation in a foreign language.

7. Course objectives

7.1. General objective	-Understanding the fundamental aspects related to the study of the special theory of relativity. Training capacities to approach and solve specific problems . -Acquiring knowledge concerning the various applications of the theory of theory of relativity. Training capacities to approach and solve specific problems.
7.2. Specific objectives	- Acquiring knowledge of specific physical theories/models - Developing the ability to work in a team - Acquiring the principles of STR, the basic notions concerning space and time, the Lorentz transformations, the relativistic kinematics and dynamics, the kinematics of relativistic collisions. - Covariant formulation of the laws of electromagnetic field (EMF). - Applying the covariant theory of EMF to the study of some physical systems: Radiation of accelerated point charge.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Physical basis of the Theory of Relativity (TR). Relativity principles. Frames of reference. Space and time. Time dilation and length contraction in Special Relativity. Lorentz transformations and their consequences. Relativistic formula of velocity addition.	Systematic exposition - lecture. Examples	2 h
Minkowski space. Lorentz transformations as orthogonal transformations in Minkowski space. The matrix of a special Lorentz transformation (boost) and its properties. Scalars, 4- vectors and 4-tensors. Scalar product and norm of 4-vectors. Differential 4-vector operators. (4-gradient, 4-divergence). Wigner rotation.	Systematic exposition - lecture. Examples	4 h
The relativistic invariant interval, classification and properties. Geometrical representation of Lorentz transformations.	Systematic exposition - lecture. Examples	1 h
Elements of relativistic kinematics. Proper time. 4-velocity, 4- acceleration and their properties. Norms and relativistic transformations.	Systematic exposition - lecture. Examples	2 h
Covariant dynamics of the relativistic particle. 4-force and 4-momentum. Covariant formulation of momentum and energy theorems. Energy-momentum relativistic relation. Relativistic transformations relations for momentum and energy. Relativistic Lagrange and Hamilton functions of the free particle and for the particle in an external field. Motion of a relativistic particle in an external EMF. Special cases	Systematic exposition - lecture. Examples	4 h
Relativistic kinematics of relativistic collisions (interactions). Center of mass frame of two particles, total mass and the center of mass velocity. Energy, momentum and velocity of one particle in the proper frame of one other and in the Center of mass frame. Applications. Laboratory frame. Independent invariant parameters of binary elastic collisions.	Systematic exposition - lecture. Examples	3 h
Covariant formulation of the laws of EMF. Covariant formulation of electric charge conservation (continuity	Systematic exposition - lecture. Examples	4 h

eq.) . 4-current of electric charge. Covariant formulation of the EM potentials in Lorenz gauge. 4-potential. Relativistic transformations of the 4-current and 4-potential. Covariant formulation of Lorenz condition. The 4-tensor of the EMF. Covariant formulation of Maxwell equations in vacuum. Relativistic invariants of the EMF. Relativistic transformations of electric and magnetic field.		
Covariant formulation of the EMF equations in media (laws of macroscopic field). Average of eqs. of microscopic field. Polarization and excitation 4-tensors. Relativistic transformations of the **P, D, M, H** vectors. Covariant formulation of the EMF energy and momentum theorems. Energy-momentum tensor of the EMF.	Systematic exposition - lecture. Examples	4 h
EMF of a point charge in arbitrary motion. Lienard-Wiechert potentials. Electric and magnetic field vectors. The field of the charge in uniform motion. Radiation field. Intensity (angular distribution) and total radiated power.	Systematic exposition - lecture. Examples	4 h

Bibliography:

C. Møller, *The Theory of Relativity*, Clarendon Press, 1955
R. Hagedorn, *Relativistic Kinematics*, W.A. Benjamin, 1964
J.L. Synge, *Relativity: The Special Theory*, Elsevier Science Ltd; 2nd ed. 1980
C. Vrejoiu, *Electrodinamica si teoria relativitatii* , Editura didactica si pedagogica, Bucuresti,1993
J . D . Jackson, *Classical electrodynamics* , 3-rd ed. , John Wiley & Sons , 1998
F.E. Low, *Classical Field Theory*. Electromagnetism and Gravitation Wiley-VCH Verlag 2004
D.J. Griffiths, *Introduction to Electrodynamics*, 4-th ed., Pearson, 2013
C. Stoica, *Note de curs, in format electronic*, pe site-ul departamentului.

8.2. Tutorials	Teaching and learning techniques	Observations
Geometry of the Minkowski spacetime: Lorentz transformation, four-vectors, tensors, relativistic invariants. The light cone and causality.	Problem solving. Guided work. Case study. Examples.	2
Applications of Lorentz transformation relation and of relativistic formula of velocities addition. Relativistic addition of accelerations. Lorentz contraction. Stellar aberration. Thomas precession, calculation of Thomas angular velocity. Thomas factor in spin-orbit coupling. Doppler shift.	Problem solving. Guided work. Case study. Examples.	4
Motion of a particle under the action of a constant and quasielastic force. Motion of a point charge in homogeneous constant electric and magnetic fields (various cases).	Problem solving. Guided work. Case study. Examples.	3
Study of relativistic collisions / decays of particles. Conservation laws in Special Relativity: the energy-momentum four-vector. The Compton effect and the inverse Compton effect.	Problem solving. Guided work. Case study. Examples.	6
Radiation reaction. Abraham-Lorentz eq. Relativistic DiracLorentz eq. Landau Lifshitz eq.	Problem solving. Guided work. Case study. Examples.	3
Applications of relativistic formulas of EMF transformations in vacuum and in material media. Transformation relations of the dipole electric and magnetic moments.	Problem solving. Guided work. Case study. Examples.	6
The field of the uniform moving charge. Cherenkov effect. Bremsstrahlung. Angular distribution and the total radiated power of a point charge in arbitrary motion. The cases of uniform linear acceleration and of circular uniform motion (synchrotron radiation). Calculation of Lienard formula of the total radiated	Problem solving. Guided work. Case study. Examples.	4

power.		
Bibliography: **V. Novacu**, *Culegere de probleme de electrodinamica*, Editura tehnica , Bucuresti , 1964 **Alan P. Lightman, William H. Press, Richard H. Price, Saul A. Teukolsky,** *Problem Book in Relativity and Gravitation*, Princeton University Press, 1975. **Michael Tsamparlis,** *Special Relativity: An Introduction with 200 Problems and Solutions,*Springer; 2010		
8.3. Practicals	Teaching and learning techniques	Observations
Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 and abilities which are fundamental for an undergraduate student in the field of modern physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, academic, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition -correct use of equations / mathematical methods / physical models and theories - ability to indicate / analyse specific examples	Written test / oral examination	60%
10.5.1. Tutorial	-ability to use specific methods for problem solving - ability to analyse the results	Homeworks/written tests	40%
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam **Attendance score of minimum 50% of Lectures and all Tutorial classes.** At least 50% of exam score and 50% of total score in the final examination.			

Date 05.11.21	Teacher's name and signature Madalina Boca	Practicals/Tutorials instructor(s) name(s) and signature(s) Virgil V. Baran

Date of approval 11.11.2021	Head of Department Lect.dr. Roxana Zus

DI 209F.EN Quantum mechanics I

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Departement of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Quantum Mechanics I							
2.2. Teacher			Prof. Dr. Virgil Băran					
2.3. Tutorials/Practicals instructor(s)			Lect. Dr. Virgil V. Băran					
2.4. Year of study	II	2.5. Semester		2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1]	DF
							Type [2]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	2	Practicals	0	Project	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	28	Practicals	0	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	15
3.3.2. Research in library, study of electronic resources, field research	10
3.3.3. Preparation for practicals/tutorials/projects/reports/homework	15
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Real and Complex Analysis, Algebra, Differential Equations, Equations of Mathematical Physics, Classical mechanics, Fundamentals of Atomic Physics
4.2. competencies	Knowledge about : - Phenomenology of microscopic behaviour of physical systems - Differential and integral calculus, partial differential equations, special functions, orthogonal polynomials -Analytical formalism of classical mechanics; classical electrodynamics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Computer, Video projector Lecture notes Bibliography
5.2. for practicals/tutorials/projects	Lecture notes Bibliography

6. Specific competences acquired

Professional competencies	Identify and proper use of the main physical laws and principles in a given context. Deduction of working formulas for calculations of physical quantities using appropriate principles and laws of physics. Description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) Use of the physical principles and laws for solving theoretical or practical problems with qualified tutoring. Rigorous knowledge of quantum theory, concepts, notions and problems in this area.

	Ability to use this knowledge in various branches of physics.
Transversal competencies	Efficient use of sources of information and communication resources and training assistance in a foreign language. Completing professional tasks efficiently and responsibly under the law and ethics specific to the subject, under qualified guidance.

7. Course objectives

7.1. General objective	-Understanding the fundamental aspects related to the study of quantum mechanics. Training capacities to approach and solve specific problems. Developing analytics skills of calculation.
7.2. Specific objectives	- Describing and understanding of specific physical theories/models for quantum systems. -Assimilation of formalism of quantum mechanics: the principles of quantum mechanics, states, observables, measurement. - Understanding the peculiar behavior of microscopic physical systems: energy quantization, nonlocality and superposition principle, incompatibility of observables and Heisenberg uncertainty principle. -Acquire the skills to describe and calculate the physical properties of quantum systems.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. The principles of quantum mechanics The superposition principle of the states in quantum mechanics The state concept in quantum mechanics. Hilbert space. Dirac bra-ket formalism. *The physical observables in quantum mechanics.* Hermitian operators. Eigenvalues and eigenvectors of Hermitian operators (discrete case). The spectral theorem. Eigenvalues and eigenvectors of Hermitian operators (continuous case). *The measurement postulate in quantum mechanics.* Compatible observables. Physical interpretation of transition amplitude. Incompatible observables. Heisenberg uncertainty relation. Interpretation. Position observable and position measurement. Linear momentum and momentum measurement. *Fundamental quantum relations.* Dirac approach. The commutator in quantum mechanics. The spatial translation in quantum mechanics. Translation operator. The generator of the translations: the linear momentum. Interpretation of the results of Stern-Gerlach experiment. The Hilbert space of the spin one-half systems. The spin one-half operator components. Commutation relations. Pauli Matrices. *The dynamical evolution in quantum mechanics.* Time evolution operator: properties. The Hamiltonian of a quantum system. Eigenvalues and eigenvectors of the Hamiltonian. Stationary states. Schrodinger equation for the evolution operator. Schrodinger equation for ket vectors.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	12 hours
2. Coordinates representation of quantum mechanics Position representation of quantum mechanics: quantum wave mechanics. Physical interpretation of the wave function. Position and linear momentum operators in coordinate representation. The time-dependent Schrodinger equation for the wave function. The continuity equation of the density of probability in	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours

quantum mechanics. Time independent Schrodinger equation for the wave function. Physical boundary conditions and energy quantization for a system in a potential well.		
3. Harmonic oscillator in quantum mechanics The harmonic oscillator in quantum mechanics. The Hamiltonian. The creation and annihilation operators (ladder operators) for harmonic oscillator. The eigenvalues and eigenvectors of the harmonic oscillator Hamiltonian. Coherent states. Definition. Basic properties. The harmonic oscillator in coordinate representation. Polynomial method.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
4. The time-independent perturbation theory General discussion and setting of the problem: non-degenerate case. Zero-order approximation and first order approximation for the state ket and energy The second order correction to the ket vector and energy.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	3 hours
5. Angular momentum in quantum mechanics The orbital angular momentum. Basic definitions, commutation relations, a set of compatible observables. The ladder operators in the algebra of angular momentum. Eigenvalues and eigenvectors of the orbital angular momentum. General angular momentum: definition, commutation relations. Ladder operators: definition and properties. Eigenvalues and eigenvectors of the general angular momentum.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	5 hours

Bibliography:

- **J.J. Sakurai, J.J. Napolitano,** *Modern quantum mechanics***,** Addison-Wesley, 2011
- **D . H . McIntyre** , *Quantum mechanics. A paradigms approach*, Pearson Education Ltd , 2014
- **L . D . Landau , E .M. Lifshitz** , *Quantum mechanics*, Butterworth -Heinemann, 2003
- **PAM Dirac,** *Principles of Quantum Mechanics*, Oxford, 1982
- **W. Greiner,** *Quantum mechanics: an introduction***,** Springer, 2001
- **L.E. Ballentine,** *Quantum Mechanics : A Modern Development (2nd Edition)*, World Scientific Publishing Company; 2014
- **V. Baran, R. Zus,** *Lecture notes on quantum mechanics*
- **S. Titeica, *Mecanica Cuantica*, Editura Academiei, 1984**

8.2. Tutorials	Teaching and learning techniques	Observations
Hermitian operators. Eigenvalues and eigenvectors of Hermitian operators (discrete case). The spectral theorem. Eigenvalues and eigenvectors of Hermitian operators (continuous case).	Problem solving. Guided work. Case study. Examples.	4 hours
The principles of quantum mechanics – applications.	Problem solving. Guided work. Case study. Examples.	6 hours
Applications in coordinate's representation of quantum mechanics. Infinite and finite potential well. Potential barrier. Tunneling effect.	Problem solving. Guided work. Case study. Examples.	8 hours
Harmonic oscillator in quantum mechanics – statistics of position and momentum - applications	Problem solving. Guided work. Case study. Examples.	4 hours
The time-independent perturbation theory – nondegenrate case. Applications: anharmonic oscillator, etc.	Problem solving. Guided work. Case study. Examples.	2 hours
Quantum theory of the orbital and general angular momentum - applications.	Problem solving. Guided work. Case study. Examples.	4 hours

Bibliography:

- **J.J. Sakurai, J.J. Napolitano,** *Modern quantum mechanics***,** Addison-Wesley, 2011
- **D . H . McIntyre** , *Quantum mechanics. A paradigms approach*, Pearson Education Ltd , 2014

▪ **L . D . Landau , E .M. Lifshitz** , *Quantum mechanics*, Butterworth -Heinemann, 2003 ▪ **PAM Dirac,** *Principles of Quantum Mechanics,* Oxford, 1982 ▪ **W. Greiner,** *Quantum mechanics: an introduction***,** Springer, 2001 ▪ **N. Zettili,** *Quantum Mechanics Concepts and Applications*, second edition, John Wiley & Sons, 2009 ▪ **V. Baran, R. Zus,** *Lecture notes on quantum mechanics* ▪ ***R. Zus, V. Băran, V.V. Băran, A.M. Croitoru, C.Iorga, D.I. Palade, Quantum Mechanics – Applications – seminar notes*** *(pdf)*

9. 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 and abilities which are fundamental for an undergraduate student in the field of modern physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, academic, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Written test/oral examination	70%
10.5.1. Tutorial	- ability to use specific problem solving methods - ability to analyse the results	Homeworks/written tests	30%
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam Attendance of at least 50% for the lectures and at least 70% for the tutorials. Correct solutions to the indicated subjects for obtaining the grade 5 from all activities, part of the continuous evaluation. Correct solutions to the indicated subjects for obtaining the grade 5 within the final exam.			

Date	Teacher’s name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
05.11.2021	Prof. Dr. Virgil Baran	Lect. Dr. Virgil V. Baran

Date of approval
11.11.2021

Head of Department
Lect.dr. Roxana Zus

DI.201F.EN Electronics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Electronics								
2.2. Teacher				Prof. Dr. Andrei BARBORICA					
2.3. Tutorials/Practicals instructor(s)				Prof. Dr. Andrei BARBORICA					
2.4. Year of study	2	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1)]	DD	
							Type[2)]	DI	

[1)] fundamental (DF), speciality (DS), complementary (DC); [2)] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution: Lecture	2	Practicals/Tutorials	2
3.2. Total hours per semester	56	distribution: 1-st semester	o 56	o 2-nd semester	0
Distribution of estimated time for study					hours
3.2.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography					25
3.2.2. Research in library, study of electronic resources, field research					15
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks					25
3.2.4. Preparation for exam					4
3.2.5. Other activities					0

3.3. Total hours of individual study	65
3.4. Total hours per semester	125
3.5. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Real and Complex Mathematical Analysis, Electricity and Magnetism
4.2. competencies	C2 Use of software packages for data analysis and visualization

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Course room, projector, screen
5.2. for practicals/tutorials	Lab room, experimental setups, power supplies, measurement instruments, oscilloscopes

6. Specific competences acquired

Professional competences	C1.2 Ability to describe physical systems, using theoretical approaches and appropriate instruments C2.4 Ability to compare the results of numerical models and simulations with literature data or experimental measurements. C4.4 Critical evaluation of the results of the implementation of physical models, including the uncertainity in experimental data. C4.5 Ability to implement, improve and extend the use of a physical model. Ability to design and implement experimental setups and devices capable of validating a physical model.
Transversal competences	CT1 Efficient and responsible fulfillment of the professional duties, while respecting the deontological laws of the domain, under qualified supervision. CT3 Efficient use of informational, communication and guided professional development resources in Romanian and another widespread foreign language.

7. Course objectives

7.1. General objective	An introduction to electronics
7.2. Specific objectives	Study of the most frequently used semiconductor devices Study of the basic circuits using semiconductor devices. An introduction to the applications of the devices and circuits.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Physical properties of semiconductors. Fermi-Dirac Distribution, Density of charge carriers in intrinsic semicondactors, Physical Phenomena in semiconductors, P and N tipe semiconductors, P-N Junction.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours

Physical Phenomena in semiconductors. Continuity equation	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
P-N Junction. Physical phenomena at the P-N junction. Diodes. I-V characteristic of a diode	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
Applications of P-N Junction. Zener diode. Varicap diode, Photodiode, LED, Tunnel Diode, Multi Junctions Devices (Diac, Triac, Thiristor)	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
Bipolar transistor Currents of bipolar transistor, Static characteristics (Common emitter(CE), Common Base (CB)), Temperature Sensitivity, Static working point of CE and CB connections for bipolar transistor , Ebers-Moll equations.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
Field effect transistor JFET, MOSFET. Amplifier circuits using FETs.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
Feedback Amplifiers.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
Operationa Amplifiers.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2-4 hours
Bibliography: ▪ Razvan BOBULESCU, Andrei BARBORICA Introduction to Electronics, Editura Universitatii din Bucuresti, 2002. ▪ P. Horowitz and W. Hill, "The art of electronics", 2nd edition, Cambridge Unversity Press,1994 ▪ Mihai P Dinca, "Electronica - Manualul studentului", vol1, Editura Universitatii din Bucuresti, 2003. ▪ J. COX, Fundamentals of Linear Electronics, Ed. Delmar, 2001		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
Some specific theme	Guided work	2-4-6 hours
Bibliography: ...whatever you decide to indicate...		
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
1. Static characteristics of semiconductor diodes (Si, Ge, LED, Zener)	Guided practical activity	2-4 hours
2. Static characteristics of bipolar transistor in common emitter configuration	Guided practical activity	2-4 hours
Static characteristics of bipolar transistor in common base configuration	Guided practical activity	2-4 hours
The oscilloscope	Guided practical activity	2-4 hours
Rectifiers, unregulated and regulated power supplies. Voltage multiplier.	Guided practical activity	2-4 hours
Static characteristics of JFET	Guided practical activity	2-4 hours
Static characteristics of MOSFET	Guided practical activity	2-4 hours
Constant current, constant voltage sources	Guided practical activity	2-4 hours
Diac, Triac, Thiristor	Guided practical activity	2-4 hours
Temperature dependence of semiconductor diode and bipolar transistor	Guided practical activity	2-4 hours
Bibliography: ▪ Razvan BOBULESCU, Andrei BARBORICA Introduction to Electronics, Editura Universitatii din Bucuresti, 2002. ▪ P. Horowitz and W. Hill, "The art of electronics", 2nd edition, Cambridge Unversity Press,1994 ▪ Mihai P Dinca, "Electronica - Manualul studentului", vol1, Editura Universitatii din Bucuresti, 2003.		
8.4. Project N/A	Teaching and learning techniques	Observations
Bibliography: N/A		

9. 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 forms/develops basic theoretical and practical competencies and abilities in the field of electronics, which are fundamental for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, secondary school teaching, see e.g. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/calendar/).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyze specific examples	Written test/oral examination	
10.5.1. Tutorials	N/A	N/A	
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Lab reports	
10.5.3. Project [only if included in syllabus]	N/A	N/A	
10.6. Minimal requirements for passing the exam 80% of the practical activities must be finalized, mark 5 for the lab examination			
Requirements for mark 5 (10 points scale) A mimimum grade of 5 for the lab examination Answering the theoretical exam questions and solving the exercises with grade 5			

Date
2.11.2021

Teacher’s name and signature
Prof. Dr. Andrei BARBORICA

Practicals/Tutorials instructor(s) name(s) and signature(s)
Prof. Dr. Andrei BARBORICA

Date of approval
11.11.2021

Head of Department
Conf.dr. Adrian Radu

DI.211F.EN Nuclear Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Nuclear Physics
2.2. Teacher	Prof. dr. Mihaela Sin

				Prof. dr. Ionel Lazanu Conf. dr. Oana Ristea					
2.3. Tutorials/Practicals instructor(s)				Conf. dr. Oana Ristea, Asist. Drd. Mihaela Parvu					
2.4. Year of study	2	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DS
							Type 2)	DI

1) fundamental (DF), specialty (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Project	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	0	Practicals	28	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	35
3.3.2. Research in library, study of electronic resources, field research	10
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	65
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	The equations of mathematical physics, physics of the atom and molecule
4.2. competencies	Knowledge of mathematics, atomic physics, programming languages and numerical methods, etc.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia devices (video)
5.2. for practicals/tutorials/projects	Nuclear Physics Laboratory equipped with radioactive isotopic sources, radiation detectors (gas, scintillators, semiconductors detectors), spectroscopic chains, multichannel analyzers, radiation monitors

6. Specific competences acquired

Professional competencies	**C1**: Identification and appropriate use of main physical laws and principles in a given context. **C1.1**: Deduction of working formulas for calculations of physical quantities using appropriate principles and laws of physics. **C1.2**: description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) **C1.3**: Applying the principles and laws of physics in problem solving theoretical or practical, in terms of qualified assistance. **C1.4**: Correct application of methods of analysis and criteria for the selection of appropriate solutions to achieve specified performance **C3**: Troubleshooting the physical conditions required using numerical and statistical methods **C3.1**: Use adequate data analysis and processing of numerical methods specific physics and mathematical statistics **C3.3**: Linking problematic methods of statistical analysis to date (to obtain measurements / calculations, data processing, interpretation). **C 3.4**: Evaluating the reliability of results and comparing them to bibliographic data or theoretical values calculated using statistical methods validation and / or numerical methods
Transversal competencies	Developing scientific thinking and reasoning based on: induction, deduction, experimental design, causal reasoning, concept formation, hypothesis testing. Applying the techniques of multidisciplinary team working on various hierarchical levels. Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	Presenting the fundamentals of nuclear physics and applications in various fields.
7.2. Specific objectives	Understanding the specific aspects of the physics at subatomic and subnuclear scale Ability to operate with these concepts and phenomena. Development of experimental skills specific to the field. Knowledge of the the structure and specific models for nuclei decays. Understanding of the specificity experiments search of the structure, elementarity and fundamental interactions of matter. Understanding main classes of applications in everyday life.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Introduction: purpose and role of subatomic physics; historic steps in discovering the structure of matter and the fundamental constituents.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
The intrinsic properties of the atomic nucleus: size, radius, density, binding energy, mass, electric charge, spin, parity, magnetic moment and quadrupole moments	Systematic exposition - lecture. Examples	8 hours
Nuclear stability: binding energy, separation energy, the liquid drop model and semi-empirical mass formula.	Systematic exposition - lecture. Heuristic conversation. Examples	4 hours
Radioactive decay: activity, half-time, the law of radioactive decay.		4 hours
Disintegration processes: alpha, beta, gamma decay; emitting nuclei, decay heat, energy spectra, decay series; applications.	Systematic exposition - lecture. Heuristic conversation.. Critical analysis. Examples	8 hours

Bibliography:

1. A Das and T. Ferbel, Introduction to Nuclear and Particle Physics, World Scientific, Second edition, 2005
2. Raymond Serway, Clement Moses, Curt Moyer, Modern Physics, Third Edition, Thomson Books/Cole, 2005 (13 Nuclear structure, 14 Nuclear physics applications, 15 Elementary particles; other only by selection)
3. http://hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html
4. http://ocw.mit.edu/OcwWeb/Nuclear-Engineering/22-101Fall-2006/LectureNotes/index.htm
5. K Heyde, Basic Ideas and Concepts in Nuclear Physics (An Introduction approach) (Graduate student series in physics, Series Editor: Douglas F Brewer), IOP Publishing Ltd, Second edition 1999
6. K. Gottfried, V. Weisskopf Concepts of particle physics Clarendon Press, 1984
7. Brian R Martin, Nuclear and Particle Physics – An Introduction, 2nd_Edition, 2009
8. WR Leo, Techniques for nuclear and particle physics experiments, 2nd Edition Springer-Verlag , 1994
9. http://ocw.mit.edu/courses/nuclear-engineering/22-55j-principles-of-radiation-interactions-fall-2004/lecture-notes/
10. Electronic support of the course
10. Manuale scrise de membrii Catedrei de Fizica atomica si nucleara, autori diferiti, diferite editii
11. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994
12 Îndrumător de laborator, Catedra de Fizică atomică şi nucleară, Ed.Univ. Bucureşti, diverse ediţii

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
1.Dosimetry 2. Experimental study of the probabilistic nature of the processes of radioactive decays	Guided practical activities	8x2 hours

3. The study of the interactions of alpha particles in air 4. The absorption of the beta particles in various materials 5. Bakscattering of the beta particles 6. Gamma atenuation in different materials 7. Gamma spectroscopy 8. Determination of the activity of a gamma ray source		
Statistical analysis of experimental data in nuclear physics Nuclear electronic elements and set-ups used in nuclear physics lab	Guided work	6 hours
Problems		4 hours
Examination		2 hours

Bibliography:
1.Electronic Lab Guide
2. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994
3. Lucrari practice de Fizica nucleara, Îndrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 1987
4. Bazele Fizicii nucleare, Lucrari practice, Indrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 2003
5. 1000 solved problems in Modern Physics, A. Kamal, Springer-Verlag, 2010
6. Problems and solutions on Atomic, Nuclear and Particle Physics, Y.-K. Lim, World Scientific, 2000

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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 theoretical and practical competences and abilities which are fundamentalfor an undergraduate student in the field of modern Physics, corresponding to national and international standards. 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 Oxford https://www.ox.ac.uk/admissions/undergraduate/courses-listing?wssl=1, Universityof Parma http://www.difest.unipr.it/it/didattica/laurea-triennale-fisica/calendario-didattico, Universitatea Padova, http://en.didattica.unipd.it/didattica/2015/SC1158/2014). The contents are in line with the requirements/expectations of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Oral examination	60%
10.5.1. Tutorial			
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Lab reports	40%

	- ability to use specific problem solving methods - ability to analyse the results		
10.5.3. Project			

10.6. Minimal requirements for passing the exam Correct understanding of the concepts and phenomena, the ability to work with them and obtain accurate numerical results on topics imposed. Requirements for mark 5 (10 points scale) Completion of all laboratory and minimal 5 score to the examination of the knowledge of the laboratory The correct answers to the subjects indicated to obtain the score 5 at the final exam.

Date
28.10.2021

Teacher's name and signature
Prof. dr. Mihaela Sin
Prof. dr. Ionel Lazanu
Conf.dr. Oana Ristea

Practicals/Tutorials instructor(s)
Conf.dr. Oana Ristea
Asist. Drd. Mihaela Parvu

Date of approval
11.11.2021

Head of Department
Prof. Dr. Alexandru Jipa

DI 212F.EN Thermodynamics and Statistical Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Thermodynamics and Statistical Physics							
2.2. Teacher				Conf. Dr. Alexandru Nicolin				
2.3. Tutorials/Practicals instructor(s)				Conf. Dr. Alexandru Nicolin				
2.4. Year of study	II	2.5. Semester	4	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1]	DF
							Type [2]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	6	distribution:	Lectures	3	Tutorials	3	Practicals	0	Project	0
3.2. Total hours per semester	84	distribution:	Lectures	42	Tutorials	42	Practicals	0	Project	0
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography										12
3.3.2. Research in library, study of electronic resources, field research										12
3.3.3. Preparation for practicals/tutorials/projects/reports/homework										13
3.3.4. Examination										4
3.3.5. Other activities										

3.4. Total hours of individual study	37
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Real and Complex Analysis, Algebra, Differential Equations, Molecular Physics
4.2. competencies	Knowledge about: - Phenomenology of microscopic behavior of physical systems - Differential and integral calculus, differential equations, special functions - Molecular physics - Computer programming

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Computer, Video projector Lecture notes Bibliography
5.2. for practicals/tutorials/projects	Lecture notes Bibliography

6. Specific competences acquired

Professional competencies	Identify and proper use of the main physical laws and principles in a given context. Deduction of working formulas for calculations of physical quantities using appropriate principles and laws of physics. Description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) Use of the physical principles and laws for solving theoretical or practical problems with qualified tutoring. Ability to use this knowledge in various branches of physics.
Transversal competencies	Efficient use of sources of information and communication resources and training assistance in a foreign language. Completing professional tasks efficiently and responsibly under the law and ethics specific to the subject, under qualified guidance.

7. Course objectives

7.1. General objective	Presentation of the general notions and methods of the neo-gibbsian thermodynamics; presentation of the general concepts and the fundamental applications of the classical and quantum statistical mechanics.
7.2. Specific objectives	- Presentation of the entropic and energetic thermodynamical representations. - General discussion of the thermodynamic equilibrium conditions. - Presentation of the principal properties of phase transitions. - Presentation of the most important equilibrium statistical ensembles: micro-canonical, canonical and grand-canonical (in classical and quantum variants). - Presentation of some approximation methods in statistical mechanics. - Deduction of the specific properties of the phase transitions using methods of statistical mechanics. - Discussion of the specific properties of the ideal quantum gases. - Presentation of selected methods of computational statistical physics

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Fundamental problems of the neo-gibbsian thermodynamics	Systematic exposition - lecture. Examples	3 hours
Thermodynamic representations	Systematic exposition - lecture. Examples	3 hours
Thermodynamic coefficients and Conditions for thermodynamic equilibrium	Systematic exposition - lecture. Examples	3 hours
Phase transitions	Systematic exposition - lecture. Examples	3 hours
The fundamentals of the classical statistical mechanics	Systematic exposition - lecture. Examples	3 hours

The fundamentals of the quantum statistical mechanics	Systematic exposition - lecture. Examples	3 hours
Equilibrium statistical ensembles	Systematic exposition - lecture. Examples	9 hours
Special topics of the classical statistical mechanics	Systematic exposition - lecture. Examples	7 hours
Special topics of the quantum statistical mechanics	Systematic exposition - lecture. Examples	8 hours
Bibliography: ▪ J.M. Yeomans, *Statistical mechanics of phase transitions*, Clarendon Press, 1992 ▪ K. Huang, *Introduction to statistical physics*, CRC Press, 2013 ▪ K. Huang, *Lectures on statistical physics and protein folding*, World Scientific 2005 ▪ K. Binder, D.W. Heermann, *Monto Carlo simulation in statistical physics: An introduction*, Springer, 2010		
8.2. Tutorials	Teaching and learning techniques	Observations
Mathematical complements for thermodynamics	Theoretical presentation and problem solving	3 hours
Thermodynamics of neutral fluid	Theoretical presentation and problem solving	4 hours
Thermodynamics of van der Waals gas	Theoretical presentation and problem solving	4 hours
Thermodynamics of thermal radiation	Theoretical presentation and problem solving	1 hours
Mathematical complements for classical and quantum statistical mechanics	Theoretical presentation and problem solving	3 hours
Micro-canonical statistical ensemble	Theoretical presentation and problem solving	3 hours
Canonical statistical ensemble	Theoretical presentation and problem solving	3 hours
Grand-canonical statistical ensemble	Theoretical presentation and problem solving	3 hours
Ideal quantum gases	Theoretical presentation and problem solving	3 hours
Special topics of computational statistical mechanics: Ising and Ising-like models	Theoretical presentation and problem solving	3 hours
Bibliography: ▪ D.A.R. Dalvit, J. Frastai, I. Lawrie, *Problems on statistical mechanics*, CRC Press, 1999 ▪ Y.-K. Lim, Problems and solutions on thermodynamics and statistical mechanics, World Scientific, 1990 ▪ J.M. Yeomans, *Statistical mechanics of phase transitions*, Clarendon Press, 1992 ▪ K. Huang, *Introduction to statistical physics*, CRC Press, 2013		

9. 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 and abilities which are fundamental for an undergraduate student in the field of modern physics, corresponding to national and European/international standards. 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/expectations of the main employers of the graduates (industry, research, academic, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyze specific examples	Written test/oral examination	50%

10.5.1. Tutorial	- ability to use specific problem solving methods - ability to analyze the results	Homework/written tests	50%
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam Attendance of at least 50% for the lectures and at least 70% for the tutorials. Correct solutions to the indicated subjects for obtaining the grade 5 from all activities, part of the continuous evaluation. Correct solutions to the indicated subjects for obtaining the grade 5 within the final exam.			

Date 05.11.2021	Teacher's name and signature Conf. Dr. Alexandru Nicolin	Practicals/Tutorials instructor(s) name(s) and signature(s) Conf. Dr. Alexandru Nicolin

Date of approval 11.11.2021	Head of Department Lect.dr. Roxana Zus

DI 214F.EN Research Activity

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Research activity							
2.2. Teacher								
2.3. Tutorials/Practicals instructor(s)	Conf.dr. Vasile Bercu							
2.4. Year of study	2	2.5. Semester	II	2.6. Type of evaluation	V	2.7. Type of course unit	Content[1)]	DS
							Type[2)]	DI

[1)] fundamental (DF), speciality (DS), complementary (DC); [2)] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum		distribution: Lecture		Tutorials/ Practicals	
3.2. Total hours per semester	90	distribution: Lecture		Tutorials/ Practicals	

Distribution of estimated time for study	hours
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	
3.2.2. Research in library, study of electronic resources, field research	4
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	3
3.2.4. Examination	3
3.2.5. Other activities	

3.3. Total hours of individual study	7
3.4. Total hours per semester	100
3.5. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Cover the courses from the first and the second year
4.2. competences	Knowledge of mathematics, physics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for practicals/tutorials	Laborator

6. Specific competences acquired

Professional competences	C1- Identify and make appropriate use of the main laws and principles of physics, in a given context. C4 – Carry out basic experiments in physics by using specific laboratory equipment. C5 – Analize and communicate basic scientific, educational and popular information on physics.
Transversal competences	CT3- Efficient use of trousted sources of scientific information and profficient communication of scientific data in English

7. Course objectives

7.1. General objective	To present the basic concepts of the field and to familiarize the students with the specific aspect of a research activity
7.2. Specific objectives	- Understandig the specific aspects and the ability to work with different phenomena; - Developing the capacity to work within a research team using laboratory equipment. -Development of experimental skills specific to the field.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Recommended lectures:		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
	Teaching and learning techniques	Observations
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
In agreement with the subject chosen for research activity	Guided practical activity	90 hours
Recommended lectures: It is to be specified for the chosen topic, by the supervising teacher and the practice coordinator; includes labor protection rules and initial training seminars for students		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography:		

9. 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 discipline meets the current requirements for the development of practical skills at national and international level in higher education. The internships will be carried out in the institutes. The companies with which the Faculty of Physics has concluded internship agreements. The targeted fields of activity are multiple, the possible targeted employers being both from the research-development environment and from other fields.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.2 Tutorials			0-100% (if applicable)
10.5.2. Practicals	- evaluation of the experimental skills acquired in the laboratory activity - evaluation of the capacity for analysis and interpretation of	Internship / activity report	100 %

	experimental results		

10.6. Minimal requirements for passing the exam The final examination is conditional on the completion of all planned activities and takes into account the observations / proposals of the practice coordinator.
Requirements for mark 5 (10 points scale) • Mandatory attendance at all activities included in the internship portfolio • Preparation of the Activity Report, following the internship • Learning the main notions, methods, techniques. Requirements for mark 10 (10 points scale) • Skills, well-argued knowledge • Demonstrated ability to analyze phenomena and processes • Personal approach and interpretation

Date 05.10.2021	Teacher's name and signature	Practical instructor, name(s) and signature(s) Conf.dr. Vasile BERCU

Date of approval
11.11.2021

Head of Department,
Prof.dr. Alexandru Jipa

DI 301F.EN Quantum mechanics II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Departement of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Quantum Mechanics II								
2.2. Teacher				Prof. Dr. Virgil Baran					
2.3. Tutorials/Practicals instructor(s)				Lect. Dr. Virgil V. Baran					
2.4. Year of study	3	2.5. Semester	5	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DF	
							Type [2)]	DI	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	2	Practicals	0	Project	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	28	Practicals	0	Project	0
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography										20
3.3.2. Research in library, study of electronic resources, field research										15
3.3.3. Preparation for practicals/tutorials/projects/reports/homework										30
3.3.4. Examination										4
3.3.5. Other activities										

3.4. Total hours of individual study	65
3.5. Total hours per semester	125

3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Real and Complex Analysis, Algebra, Differential Equations, Equations of Mathematical Physics, Classical mechanics, Fundamentals of Atomic Physics, Quantum Mechanics I
4.2. competencies	Knowledge about : - Phenomenology of microscopic behaviour of physical systems - Differential and integral calculus, partial differential equations, special functions, orthogonal polynomials -Analytical formalism of classical mechanics; classical electrodynamics -Principles of quantum mechanics, representations of Quantum Mechanics, angular momentum in Quantum Mechanics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Computer, Video projector Lecture notes Bibliography
5.2. for practicals/tutorials/projects	Lecture notes Bibliography

6. Specific competences acquired

Professional competencies	Identify and proper use of the main physical laws and principles in a given context. Deduction of working formulas for calculations of physical quantities using appropriate principles and laws of physics. Description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) Use of the physical principles and laws for solving theoretical or practical problems with qualified tutoring. Rigorous knowledge of quantum theory, concepts, notions and problems in this area. Ability to use this knowledge in various branches of physics.
Transversal competencies	Efficient use of sources of information and communication resources and training assistance in a foreign language. Completing professional tasks efficiently and responsibly under the law and ethics specific to the subject, under qualified guidance.

7. Course objectives

7.1. General objective	-Understanding the fundamental and advanced aspects related to the study of quantum mechanics. Training capacities to approach and solve specific problems. Developing analytics skills of calculation.
7.2. Specific objectives	- Describing and understanding of specific physical theories/models for quantum systems. -Assimilation of formalism of quantum mechanics - Understanding the peculiar behavior of microscopic physical systems (inlcuding identical particles). -Acquire the skills to describe and calculate the physical properties of quantum systems.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Theory of rotations in Quantum Mechanics The rotation operator. The angular momentum operator as the generator of rotations. Wigner functions: physical interpretation. Systems of spin ½ particles. The Pauli formalism.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
2. The addition of angular momenta The quantum mechanical description of combination of two physical systems. Two spin one-half systems. General discussion. Maximal sets of mutually compatible observables. Possible bases in the Hilbert space of total system. The formal theory of angular momentum addition. Clebsch-	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	5 hours

Gordon coefficients. Interpretation. Basic properties of Clebsch-Gordon coefficients. Recursion relations for Clebsch-Gordan coefficients. Clebsch-Gordan series. Addition of orbital angular momentum with the spin one-half angular momentum. Spherical tensors. Definition. Products of spherical tensor operators. Wigner-Eckart theorem.		
3. Kepler problem in quantum mechanics Formulation of the problem. System of compatible observables. Coordinates representation of time independent Schrodinger equation. Coulomb potential. Eigenvalues and eigenvectors for hydrogen atom.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
4. The time-independent perturbation theory – degenerate case Perturbation theory for the degenerate case. Variational method for ground state and excited states. Ritz approach.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	3 hours
5. Particle motion in a magnetic field. The Pauli equation The Hamiltonian of a charged particle in the electromagnetic field. The Schrodinger equation. The Bohr-Procopiu magneton. The Pauli equation. The vector potential in quantum mechanics. The gauge invariance in quantum mechanics. Bohm-Aharonov effect. Modern Applications: Landau levels and integral quantum Hall effect	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
6. Systems of identical particles in quantum mechanics The principle of identity of like-particles in microscopic world; exchange degeneracy. Permutation operator; symmetrization and antisymmetrization operators for systems of two identical particles.The symmetrisation postulate: bosons and fermions.The state ket for a system of three bosons. Slater determinants. Systems of two electrons. Fock space.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
7.Theory of time-dependent perturbations Schrödinger, Heisenberg and interaction (Dirac) pictures of quantum mechanics. Time evolution operator: definition, properties, Dyson perturbative expansion for time evolution operator. Transition amplitude. Transition probability. Step pertubation and Fermi's golden rule for transition rate. The case of a periodic perturbation:stimulated electromagnetic transitions. Dipole approximation. The scattering theory. The scattering amplitude and cross section. The perturbative approach and the relation with time-dependent perturbation theory.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours

Bibliography:

- **J.J. Sakurai, J.J. Napolitano,** *Modern quantum mechanics***,** Addison-Wesley, 2011
- **D . H . McIntyre** , *Quantum mechanics. A paradigms approach,* Pearson Education Ltd , 2014
- **L . D . Landau , E .M. Lifshitz** , *Quantum mechanics,* Butterworth -Heinemann, 2003
- **PAM Dirac,** *Principles of Quantum Mechanics,* Oxford, 1982
- **W. Greiner,** *Quantum mechanics: an introduction***,** Springer, 2001
- **L.E. Ballentine,** *Quantum Mechanics : A Modern Development (2nd Edition),* World Scientific Publishing Company; 2014
- **V. Baran, R. Zus,** *Lecture notes on quantum mechanics*
- **A. Messiah,** Quantum Mechanics, Dover Publications 1999
- **S. Titeica,** ***Mecanica Cuantica*****, Editura Academiei, 1984**

8.2. Tutorials	Teaching and learning techniques	Observations
General theory of angular momentum (commutation relations, rotations, etc.)	Problem solving. Guided work. Case study. Examples.	2 hours
Systems of spin ½ particles - applications	Problem solving. Guided work. Case study. Examples.	2 hours
The addition of angular momenta – applications for particles with	Problem solving. Guided work.	6 hours

spin ½ and 1. Addition of orbital angular momentum with the spin one-half angular momentum.	Case study. Examples.	
Hydrogen atom. Applications	Problem solving. Guided work. Case study. Examples.	4 hours
The time-independent perturbation theory – degenerate case. Applications: Stark effect etc.	Problem solving. Guided work. Case study. Examples.	3 hours
Quantum dynamics of particles in the electromagnetic field. Pauli equation – applications: Landau levels, Zeeman effect and Quantum Hall effect.	Problem solving. Guided work. Case study. Examples.	4 hours
Systems of identical particles in quantum mechanics – problems and applications	Problem solving. Guided work. Case study. Examples.	3 hours
Theory of time-dependent perturbations – applications	Problem solving. Guided work. Case study. Examples.	4 hours

Bibliography:

- **J.J. Sakurai, J.J. Napolitano,** *Modern quantum mechanics***,** Addison-Wesley, 2011
- **D . H . McIntyre** , *Quantum mechanics. A paradigms approach*, Pearson Education Ltd , 2014
- **L . D . Landau , E .M. Lifshitz** , *Quantum mechanics*, Butterworth -Heinemann, 2003
- **PAM Dirac,** *Principles of Quantum Mechanics,* Oxford, 1982
- **W. Greiner,** *Quantum mechanics: an introduction***,** Springer, 2001
- **N. Zettili,** *Quantum Mechanics Concepts and Applications*, second edition, John Wiley & Sons, 2009
- **V. Baran, R. Zus,** *Lecture notes on quantum mechanics*
- ***R. Zus, V. Băran, V.V. Băran, A.M. Croitoru, C.Iorga, D.I. Palade, Quantum Mechanics – Applications – seminar notes*** *(pdf)*

9. 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 and abilities which are fundamental for an undergraduate student in the field of modern physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, academic, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples -ability to apply the gained knowledge to solve specific prolems (angular momentum coupling, Hydrogen atom, Stark effect, Zeeman effect, etc.)	Written test/oral examination	70%
10.5.1. Tutorial	- ability to use specific problem solving methods - ability to analyse the results	Homeworks/written tests	30%
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam Attendance of at least 50% for the lectures and at least 70% for the tutorials. Correct solutions to the indicated subjects for obtaining the grade 5 from all activities, part of the continuous evaluation. Correct solutions to the indicated subjects for obtaining the grade 5 within the final exam. 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 05.11.2021	Teacher’s name and signature Prof. Dr. Virgil Baran	Practicals/Tutorials instructor(s) name(s) and signature(s) Lect. Dr. Virgil V. Baran
Date of approval 11.11.2021	Head of Department Lect.dr. Roxana Zus	

DI.302F.EN Molecular Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Molecular Physics**							
2.2. Teacher				Conf.dr. Vasile Bercu				
2.3. Tutorials/Practicals instructor(s)				Conf.dr. Vasile Bercu				
2.4. Year of study	2	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DF
							Type 2)	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	1	Practicals	1	Project	-
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	14	Practicals	14	Project	-
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography										20
3.3.2. Research in library, study of electronic resources, field research										15
3.3.3. Preparation for practicals/tutorials/projects/reports/homework										30
3.3.4. Examination										4
3.3.5. Other activities										-

3.4. Total hours of individual study	65
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Fundamentals of Atomic Physics, Quantum mechanics, Real and Complex analysis, Equations of Mathematical Physics
4.2. competencies	Knowledge of Atomic Physics, Quantum mechanics and Mathematics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphitheater equipped with multimedia devices (video)
5.2. for practicals/tutorials/projects	Laboratory with experimental set up for atomic and molecular physics experiments

	Computers

6. Specific competences acquired

Professional competencies	C1: Identification and appropriate use of main physical laws and principles in a given context. C2: Use of software for analysis and data processing. C3: Troubleshooting the physical conditions required using numerical and statistical methods C4: Applying knowledge in the field of physics both in concrete situations from related fields as well as in experiments, using standard laboratory equipment C5: Communication and analysis of didactic, scientific and dissemination of information C6: Interdisciplinary approach to physics topics.
Transversal competencies	CT1- Achievement of the professional duties in an efficient and responsible way with compliance with deontological legislation specific to the domain under qualified assistance. CT3: Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	Assimilation of theoretical and experimental foundations of phenomena related to the atomic and molecular physics
7.2. Specific objectives	Familiarization with the fundamental concepts and models in the field of atomic and molecular physics; Acquiring scientific methods of analysis; Description and understanding of mathematical methods associated with the field of atomic and molecular physics; Developing the ability to quantitatively analyze specific cases and to interpret the fundamental phenomena in the field; Development of the ability to apply appropriate numerical models for modeling phenomena from the atomic and molecular level; Development of experimental skills and acquisition of the main principles used in atomic and molecular physics.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
The Schrödinger equation for one-electron atoms - the atomic orbitals and the energy levels	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
Alkali metal atoms - dipole approximation - the energy levels	Systematic exposition - lecture. Critical analysis.	2 hours
One-electron atoms in external magnetic field -the Zeeman effect	Systematic exposition -lecture. Heuristic conversation.	2 hours
The electron spin in one electron atom - the total wave function and the energy levels	Systematic exposition -lecture. Heuristic conversation.	1 hours
Many-electron atoms -systems of fermions, the wave function, the Pauli principle - the He atom - the central field approximation - the Hartree-Fock theory, the self consistent field method - electronic configuration and the Mendeleev table	Systematic exposition - lecture.Examples.	4 hours
The Born Oppenheimer approximation - the H_2^+ molecular ion, the H_2 hydrogen molecule - molecular orbital calculation for H_2	Systematic exposition - lecture. Heuristic conversation.	6 hours
Molecular orbitals of polyatomic molecules - the Huckel method - the Valence electron approximation - Molecular orbital hybridization	Systematic exposition - lecture. Critical analysis. Examples	5 hours

Hartree Fock LCAO method for polyatomic molecules - Electronic configuration and molecular geometry in the ground state	Systematic exposition - lecture. Heuristic conversation. Examples	6 hours
Bibliography: - Physics of Atoms and Molecules, B. H. Bransden si C. J. Joachain, Bucuresti, 1998 - Fizica atomică- Vol II, V. Spolschi, Editura Tehnica, 1953 - Molecular spectroscopy, Ira N. Levine, New York ; John Wiley &Sons, 1975 - Atkins' physical chemistry - Peter Atkins, Julio de Paula, Oxford University Press, 2010 - Introduction to quantum mechanics : with applications to chemistry, Linus Pauling and E. Bright Wilson, New York ; McGraw-Hill Book Company, 1935 - Introduction to infrared and Raman spectroscopy Norman B. Colthup, Lawrence H. Daly and Stephen E. Wiberley, New York ; Academic Press, 1964 - Quantum physics of atoms, molecules, solids, nuclei and particles Robert Martin Eisberg and Robert Resnick, New York ; John Wiley & Sons, 1974 - The physics of atoms and quanta : introduction to experiments and theory Haken, Hermann Wolf, Hans Christoph Berlin; Springer, 1994		
8.2. Tutorials	Teaching and learning techniques	Observations
Principles of molecular spectroscopy and data processing: architecture and principles of optical spectrometers, spectral lines and physical meanings of associated parameters	Example. Problems. Guided work	2 hours
Symmetry of molecules. Point groups of symmetry. Symmetry elements and operations. Photon absorption processes, selection rules.	Example. Problems. Guided work	6 hours
Identification of the spectral signature and atomic configuration for AB_3 molecules (CO_3 group in carbonates) from the IR spectra using irreducible representations of symmetry groups.	Example. Problems. Guided work	2 hours
Determination of the C_6H_6 molecule configuration from the Raman spectra using the group theory.	Example. Problems. Guided work	2 hours
Numerical methods for polyatomic molecules: HF method, DFT method	Example. Problems. Guided work	2 hours
Bibliography: - Physics of Atoms and Molecules, B. H. Bransden si C. J. Joachain, Bucuresti, 1998 - Fizica atomică- Vol II, V. Spolschi, Editura Tehnica, 1953 - Molecular spectroscopy, Ira N. Levine, New York ; John Wiley &Sons, 1975 - Atkins' physical chemistry - Peter Atkins, Julio de Paula, Oxford University Press, 2010 - Introduction to quantum mechanics : with applications to chemistry, Linus Pauling and E. Bright Wilson, New York ; McGraw-Hill Book Company, 1935 - Introduction to infrared and Raman spectroscopy Norman B. Colthup, Lawrence H. Daly and Stephen E. Wiberley, New York ; Academic Press, 1964 - Quantum physics of atoms, molecules, solids, nuclei and particles Robert Martin Eisberg and Robert Resnick, New York ; John Wiley & Sons, 1974 - The physics of atoms and quanta : introduction to experiments and theory Haken, Hermann Wolf, Hans Christoph Berlin; Springer, 1994		
8.3. PracticalsDetermination of the specific charge of the electron	Teaching and learning techniques	Observations
Determination of the the spin-orbit interaction energy and optical transition probabilities for Na atoms	Guided practical activities	2 hours
HCl molecule: extraction of the rotation-vibration parameters from molecular spectra of diatomic molecules	Guided practical activities	4 hours
The Zeeman effect: magnetic resonance spectroscopy	Guided practical activities	4 hours
Spectra of multielectronic atoms: He, Hg	Guided practical activities	4 hours
Bibliography: - Fizica atomica : lucrari practice , colectiv de autori: Elena Borca, et al.Tipografia Universitatii din Bucuresti, 1984		

- Lucrari practice de fizica atomica, care se gasesc pe site-ul : htttp://brahms.fizica.unibuc.ro/atom/atom/LabAtom.php - Fizica atomica: note de curs, Florin Popescu si Florin Marica ; Ars Docendi, 1998 - Physics of Atoms and Molecules, B. H. Bransden si C. J. Joachain, Bucuresti, 1998 - Fizica atomică - Vol I, V. Spolschi, Editura Tehnica, 1953 - Atkins' physical chemistry - Peter Atkins, Julio de Paula, Oxford University Press, 2010 - Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics -Wolfgang Demtröder Springer; 2nd ed. 2010 - Quantum physics of atoms, molecules, solids, nuclei and particlesRobert Martin Eisberg and Robert Resnick, New York ; John Wiley & Sons, 1974 - The physics of atoms and quanta : introduction to experiments and theory Haken, Hermann Wolf, Hans Christoph Berlin; Springer, 1994

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 forms/develops some theoretical and/or practical competences and abilities which are fundamental for an undergraduate student in the field of modern Physics, corresponding to national and European/international standards. 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.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/ mathematical methods/physical models and theories - ability to indicate/analyses specific examples - ability to solve course-specific practical problems	Continuous Evaluation a) Partial examination of theoretical knowledge: written and oral b) Answers and activity during the lectures c) Final examination of theoretical knowledge: written and oral For online assessment, the subjects will be electronically sent via Google Classroom / Microsoft Teams, and during the exam students will have their video camera turned on, the exam being recorded.	30% 5% 30%
10.5.1. Tutorial	- ability to use specific problem solving methods - ability to analyses the results	Homework and answers during the tutorials	10 %
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Colloquium examination	25%
10.5.3. Project			

10.6. Minimal requirements for passing the exam Attendance at least 50% of the number of class hours and compulsory attendance at all laboratory and tutorials meetings. To obtain minimum the mark 5 from evaluation criteria. Requirements for mark 5 (10 points scale) Demonstrate conceptual understanding of fundamental principles of atomic and molecular physics. Know the notions related to atomic orbitals and energy levels in the hydrogen-like atom and using these notions in solving specific applications. Correct understanding of the notions related to the dipole approximation of the core potential for alkali metals and the effect of an external magnetic field on a hydrogen like atom energy levels. Correct understanding of the consequences of electron spin on the energy structure of hydrogen like atom and solving specific applications. Knowing how to to apply Pauli's principle and use different approximations for the multi-electron atom; Correct understanding of notions related to atomic configurations, terms and energy of multi-electron atoms and solving specific applications. Correct understanding of the notions related to the Born Oppenheimer approximation and the consequences on simple molecules. Know how to apply different methods in calculating the orbitals of molecules. Know how to use the fundamental concept of molecular physics in applications.

Date 4.11.2021	Teacher’s name and signature Conf. dr. Vasile Bercu	Practicals/Tutorials instructor(s) name(s) and signature(s) Conf.dr. Vasile Bercu

Date of approval
11.11.2021

Head of Department
Prof.dr. Alexandru Jipa

DI.303F.EN Solid State Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Solid State Physics							
2.2. Teacher			Prof.dr. Daniela Dragoman					
2.3. Tutorials/Practicals instructor(s)			Conf.dr. George-Alexandru Nemneş					
2.4. Year of study	3	2.5. Semester	5	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	5	distribution:	Lectures	3	Tutorials	1	Practicals	1
3.2. Total hours per semester	70	distribution:	Lectures	42	Tutorials	14	Practicals	14
3.3 Distribution of estimated time for study								hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography								35
3.3.2. Research in library, study of electronic resources, field research								35
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks								31
3.3.4. Examination								4
3.3.5. Other activities								-

3.4. Total hours of individual study	101
3.5. Total hours per semester	175
3.6. ECTS	7

4. Prerequisites (if necessary)

4.1. curriculum	Courses: Electricity and magnetism, Quantum Mechanics I, Equations of mathematical physics, Electrodynamics and Relativity theory, Thermodynamics and Statistical mechanics
4.2. competencies	Abilities of Computational Physics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC)
5.2. for practicals/tutorials/projects	Seminar room/specific laboratory infrastructure

6. Specific competences acquired

Professional competencies	Proper identification and use of basic laws, notions and principles specific for condensed matter physics Solving physics problems under given circumstances Performing Physics experiments using standard lab equipment and evaluating the results based on theoretical models Applying creatively the acquired knowledge toward understanding and modeling the processes and physical properties of condensed matter Communication and analysis of scientific information in physics Using specific software packages for data analysis and processing
Transversal competencies	Efficient use of information sources and communication and training resources in an international language Accomplishing professional tasks in an efficient and responsible manner by abiding to legislation and specific ethical and deontological rules, under supervised assistance

7. Course objectives

7.1. General objective	Knowledge of phenomena and specific physical properties of condensed matter
7.2. Specific objectives	Study of crystalline structures and their symmetry properties Study of atoms' dynamics in crystals – phonons, thermodynamic properties Study of the electronic energy spectrum in crystalline solids Study of transport phenomena Presentation at each studied topic of the corresponding applications and of problems that allow students to understand the phenomena and to develop a creative thinking, essential for solving practical problems

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Crystalline structures. Symmetry elements. Reciprocal lattice. X-ray diffraction	Systematic exposition - lecture. Examples	9 hours
Basic notions of crystal binding	Systematic exposition - lecture. Examples	3 hours
Lattice oscillations. Acoustical and optical phonons. Phononic heat capacity	Systematic exposition - lecture. Examples	9 hours
Electron dynamics. Tight-binding model. Electronic band structure. Classification of solids	Systematic exposition - lecture. Examples	6 hours
Statistics of charge carriers in metals, intrinsic and extrinsic semiconductors. Electronic specific heat	Systematic exposition - lecture. Examples	6 hours
Kinetics of charge carriers in solids. Boltzmann formalism. Relaxation time approximation. Electrical conductivity	Systematic exposition - lecture. Examples	6 hours
Charge transport in magnetic field. Hall effect. Magnetoresistance.	Systematic exposition - lecture. Examples	3 hours
Bibliography: ▪ I. Licea, Fizica corpului solid (Editura Universității din București, București, 1991).		

▪ Ch. Kittel, Introduction to Solid State Physics (8th ed., John Wiley & Sons, New York, 2004). ▪ Y.M. Galperin, Introduction to Modern Solid State Physics (CreateSpace Publishing Platform, 2014), https://folk.uio.no/yurig/fys448/f448pdf.pdf. ▪ N.W. Ashcroft, N.D. Mermin, Solid State Physics (Harcourt College, Fort Worth, USA, 1976) ▪ D. Dragoman, Note de curs (pdf)		
8.2. Tutorials	Teaching and learning techniques	Observations
Crystalline structures. Symmetry properties, X-ray diffraction	Theoretical exposition. Problem solving	3 hours
Lattice vibrations. Dispersion laws. Density of oscillations	Theoretical exposition. Problem solving	3 hours
Electronic structure of crystalline solids. Density of states; dimensionality effects	Theoretical exposition. Problem solving	3 hours
Electrical conductivity in the relaxation time approximation. Applications	Theoretical exposition. Problem solving	2 hours
Electrical conductivity in the relaxation time approximation in magnetic fields. Applications	Theoretical exposition. Problem solving	3 hours
Bibliography: ▪ I. Licea, Fizica corpului solid (Editura Universității din București, București, 1991). ▪ Ch. Kittel, Introduction to Solid State Physics (8th ed., John Wiley & Sons, New York, 2004). ▪ Y.M. Galperin, Introduction to Modern Solid State Physics (CreateSpace Publishing Platform, 2014), https://folk.uio.no/yurig/fys448/f448pdf.pdf. ▪ N.W. Ashcroft, N.D. Mermin, Solid State Physics (Harcourt College, Fort Worth, USA, 1976) ▪ D. Dragoman, Note de curs (pdf)		
8.3. Practicals	Teaching and learning techniques	Observations
Crystallography	Guided practical activity	2 hours
X-ray diffraction		2 hours
Electrical conduction in metals. Temperature dependence of resistivity	Guided practical activity	2 hours
Electrical conduction in semiconductors. Bandgap determination	Guided practical activity	2 hours
Hopping mechanism of electrical conduction	Guided practical activity	2 hours
Hall effect	Guided practical activity	2 hours
Magnetoresistive effect	Guided practical activity	2 hours
Bibliography: ▪ C. Berbecaru, L. Ion, Fizica solidului – Caiet de lucrări de laborator • C. Kittel, Introduction to Solid State Physics (8th ed., John Wiley & Sons, New York, 2004).		
8.4. Project Not Applicable	Teaching and learning techniques	Observations
Bibliography:		

9. 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 content is in agreement with the content of similar courses taught at national and international universities, such as University Babeş-Bolyai, Cluj Napoca, University „Alexandru Ioan Cuza”, Iași and, respectively, University of Groningen, Netherlands, Warwick University, UK, University of Tubingen, Germany, Technical University Wien, Austria, etc. The course forms abilities and competences to analyze specific phenomena of condensed matter physics, to plan and execute specific experiments, and toidentify applications of acquired knowledge. These competences and abilities are in line with the requirements/expectations of the main employers of graduate students (research institutes in material physics, industry, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment	10.3. Weight in

		methods	final mark
10.4. Lecture	Clarity, coherence and concision of exposition; Proper use of physical models and mathematical formalism; Capacity of exemplification; Capacity to apply the acquired knowledge to problem solving.	Written exam	60%
10.5.1. Tutorial	Application of specific solving methods for a given problem	On-going evaluation; solving of given homeworks	20%
10.5.2. Practical	Proper use of physical models and mathematical formalism; Knowledge of specific experimental techniques and instrumentation	Lab colloquium	20%
10.5.3. Project	Not applicable	Not applicable	Not applicable
10.6. Minimal requirements for passing the exam Attendance at all practical and tutorial activities and mark 5 at the corresponding evaluations Solving of selected subjects for mark 5 at the final written exam			

Date 06.11.2021	Teacher’s signature Prof.dr. Daniela Dragoman	Practicals/Tutorials instructor’s signature Conf.dr. George Alexandru Nemneș

Date of approval
11.11.2021

Head of Department
Conf.dr. Adrian Radu

DI.304F.EN Particle Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Particle Physics							
2.2. Teacher				Prof. dr. Mihaela Sin Prof. dr. Ionel Lazanu				
2.3. Tutorials/Practicals instructor(s)				Conf. dr. Oana Ristea, Asist. Drd. Mihaela Parvu				
2.4. Year of study	3	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DS
							Type 2)	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	1	Practicals	1	Project	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	14	Practicals	14	Project	0
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography										55

3.3.2. Research in library, study of electronic resources, field research	15
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	90
3.5. Total hours per semester	150
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	The equations of mathematical physics, physics of the atom and molecule
4.2. competencies	Knowledge of mathematics, physics atomic, programming languages and numerical methods, etc.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphytheatre equipped with multimedia devices (video)
5.2. for practicals/tutorials/projects	Radioactive isotopic sources, experimental set up for nuclear spectroscopy, radiation detectors (gas, scintillators, semiconductors detectors), multichannel analyzers, radiation monitors

6. Specific competences acquired

Professional competencies	**C1**: Identification and appropriate use of main physical laws and principles in a given context. **C1.1**: Deduction of working formulas for calculations of physical quantities using appropriate principles and laws of physics. **C1.2**: description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) **C1.3**: Applying the principles and laws of physics in problem solving theoretical or practical, in terms of qualified assistance. **C1.4**: Correct application of methods of analysis and criteria for the selection of appropriate solutions to achieve specified performance **C3**: Troubleshooting the physical conditions required using numerical and statistical methods **C3.1**: Use adequate data analysis and processing of numerical methods specific physics and mathematical statistics **C3.3**: Linking problematic methods of statistical analysis to date (to obtain measurements / calculations, data processing, interpretation). **C 3.4**: Evaluating the reliability of results and comparing them to bibliographic data or theoretical values calculated using statistical methods validation and / or numerical methods
Transversal competencies	CT2: Applying the techniques of effective multidisciplinary team working on various hierarchical levels. CT3: Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	Presenting the fundamentals of nuclear and elementary particle physics and possible applications in various fields.
7.2. Specific objectives	Understanding the specific aspects of the physics at subatomic and subnuclear scale Ability to operate with these concepts and phenomena. Development of experimental skills specific to the field. Knowlege of the the structure and specific models for nuclei decays. Understanding of the specificity experiments search of the structure, elementarity and fundamental interactions of matter. Understanding main classes of applications in everyday life.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Revision on the static properties of nuclei; the need for	Systematic exposition -	2 hours

modeling of nuclear structure.	lecture. Heuristic conversation. Critical analysis. Examples	
Classes of models for the nuclear structure: collective models, models of independent particles, unified models. Illustrations: the nuclear Fermi gas model, nuclear shell models, Bohr model Mottelshon; Comparing the predictions of the nuclear models with the experimental results; defficiences of the models of the nuclear structure; ways of developing the nuclear structure models.	Systematic exposition - lecture. Examples	6 hours
Nuclear forces: experimental basis; types of interactions, properties; properties of nuclear forces.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 hours
Models for nuclear decays	Systematic exposition - lecture. Heuristic conversation.. Examples	6 hours
Nuclear reactions: definitions, classification criteria; conservation laws; kinematics of the nuclear reactions. Mechanisms of reaction.	Systematic exposition - lecture. Heuristic conversation.. Examples	4 hours
Elementary particles: classification criteria, specific quantum numbers. Experimental methods for determining the mass and the life time. Elementarity concept. Fundamental Interactions. Symmetries. Naive quark model and color concept. The standard model. Higgs boson.	Systematic exposition - lecture. Critical analysis. Examples	4 hours
Applications of Nuclear Physics in different areas of life. Perspective directions in elementary particle physics.	Systematic exposition - lecture. Examples	2 hours

Bibliography:

1. A Das and T. Ferbel, Introduction to Nuclear and Particle Physics, World Scientific, Second edition, 2005
2. Raymond Serway, Clement Moses, Curt Moyer, Modern Physics, Third Edition, Thomson Books/Cole, 2005 (13 Nuclear structure, 14 Nuclear physics applications, 15 Elementary particles; other only by selection)
3. http://hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html
4. http://ocw.mit.edu/OcwWeb/Nuclear-Engineering/22-101Fall-2006/LectureNotes/index.htm
5. K Heyde, Basic Ideas and Concepts in Nuclear Physics (An Introduction approach) (Graduate student series in physics, Series Editor: Douglas F Brewer), IOP Publishing Ltd, Second edition 1999
6. K. Gottfried, V. Weisskopf Concepts of particle physics Clarendon Press, 1984
7. Brian R Martin, Nuclear and Particle Physics – An Introduction, 2nd_Edition, 2009
8. WR Leo, Techniques for nuclear and particle physics experiments, 2nd Edition Springer-Verlag , 1994
9. http://ocw.mit.edu/courses/nuclear-engineering/22-55j-principles-of-radiation-interactions-fall-2004/lecture-notes/
10. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994
11. Gh.Vlăducă – Elemente de Fizică nucleară – vol.I, II, Tipografia (Editura) Universităţii din Bucureşti, 1988, 1990
12. K.N.Muhin – Fizică nucleară experimentală – vol.I, II, Editura Tehnică, Bucureşti, 1981, 1982
13. R.Ion-Mihai, M.L.Ion – Introducere în Fizica nucleară – Editura Universităţii din Bucureşti, 2003
14. Colectiv catedră – Fizică nucleară. Lucrări de laborator – Tipografia Universităţii din Bucureşti, 1982, 1986
15. M.Sin (editor) – Bazele Fizicii nucleare. Lucrări de laborator – Editura Universităţii din Bucureşti, 2003
16. C. Beşliu, Al.Jipa – Modele de structură nucleară şi mecanisme de recaţie – Editura Universităţii din Bucureşti, 2002

8.2. Tutorials	Teaching and learning techniques	Observations
Elements of electronic used in nuclear physics lab; temporal coincidences in nuclear experiments	Guided work	6 hours
Detectors. General Properties. Detector types. Methods for processing the signal.	Guided work	4 hours
Problems	Guided work	2 hours

Bibliography:

1. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994
2. Lucrari practice de Fizica nucleara, Îndrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 1987
3. Bazele Fizicii nucleare, Lucrari practice, Indrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 2003
4. 1000 solved problems in Modern Physics, A. Kamal, Springer-Verlag, 2010

5. Problems and solutions on Atomic, Nuclear and Particle Physics, Y.-K. Lim, World Scientific, 2000		
8.3. Practicals	Teaching and learning techniques	Observations
1. Activation law 2. Moderation of neutrons 3. Determination of half-life of radionuclides from beta decay curves 4. Beta spectroscopy and internal conversion 5. The method of gamma-gamma delayed coincidence for activity measurements. Determination of life time for excited nuclear states. 6. Moessbauer Effect. Determination of some parameters of nuclear structure 7. Identification of elementary particles and their interactions	Guided practical activities	7x2 hours
Examination		2 hours
Bibliography: 1. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994 2. Lucrari practice de Fizica nucleara, Îndrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 1987 3. Bazele Fizicii nucleare, Lucrari practice, Indrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 2003 4. 1000 solved problems in Modern Physics, A. Kamal, Springer-Verlag, 2010 5. Problems and solutions on Atomic, Nuclear and Particle Physics, Y.-K. Lim, World Scientific, 2000		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 forms/develops some theoretical and/or practical competences and abilities which are important/fundamental/something else for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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 străinătate (University of Oxford https://www.ox.ac.uk/admissions/undergraduate/courses-listing?wssl=1, Universityof Parma http://www.difest.unipr.it/it/didattica/laurea-triennale-fisica/calendario-didattico, Universitatea Padova, http://en.didattica.unipd.it/didattica/2015/SC1158/2014). The contents are in line with the requirements/expectations of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Oral examination	60%
10.5.1. Tutorial	- ability to use specific problem solving methods - ability to analyse the results	Homeworks/written tests	10%
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Lab reports	30%
10.5.3. Project			
10.6. Minimal requirements for passing the exam Correct understanding of the concepts and phenomena, the ability to work with them and obtain accurate numerical			

results on topics imposed. Requirements for mark 5 (10 points scale) Completion of all laboratory and minimal 5 score to the examination of the knowlege of the laboratory The correct answers of the subjects indicated to obtain the score 5 at the final exam.

Date 08.11.2021	Teacher’s name and signature Prof. dr. Mihaela Sin Prof. dr. Ionel Lazanu	Practicals/Tutorials instructor(s) Conf.dr. Oana Ristea Asist. Drd. Mihaela Parvu
Date of approval 11.11.2021		Head of Department Prof. Dr. Alexandru Jipa

DI.305F.EN Spectroscopy and Lasers

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Spectroscopy and Lasers							
2.2. Teacher				Associated Professor Gruia Ion Associated Professor Ionita Iulian				
2.3. Tutorials/Practicals instructor(s)				Associated Professor Gruia Ion Associated Professor Ionita Iulian				
2.4. Year of study	III	2.5. Semester	V	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DS
							Type 2)	DI

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	X	Practicals	2	Project	X
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	X	Practicals	28	Project	X
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography										15
3.3.2. Research in library, study of electronic resources, field research										10
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks										15
3.3.4. Examination										4
3.3.5. Other activities										X

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Mathematical Analysis, Optics, Electricity, Molecular Physics, Fundamentals of Atomic Physics, Quantum mechanics
4.2. competencies	Physical data processing and numerical methods

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia equipped class (videoprojector)

	Lecture notes Recommended bibliography
5.2. for practicals/tutorials/projects	Laboratory of Atomic Spectroscopy with spectral instruments and computers. Laboratory of Lasers.

6. Specific competences acquired

Professional competencies	C1 - Identification and appropriate use of main laws and principles of physics in a given context. C3 - Solving problems of physics in imposed conditions, using numerical and statistical methods C4 – Applying knowledge from the field of physics both in concrete situations from related fields, as well as in some experiments, using the standard laboratory equipment. C5 - Communication and analysis of information with didactic, scientific and popularization character in the field of physics.
Transversal competencies	CT1 – Achievement of professional tasks in efficient and responsible way with the compliance of ethics legislation specific to the field, under qualified assistance. CT2 - Application of efficient working techniques in multidisciplinary team on different hierarchical levels CT3 - Efficient use of information sources and of resources of communication and formation in a foreign language

7. Course objectives

7.1. General objective	Knowledge of fundamental phenomena of spectroscopy and lasers physics, understanding of operation of both spectral instruments and lasers.
7.2. Specific objectives	- Study of spectral terms and of mono and divalent atom spectra. study of different laser types. - Highlighting of essential issues at each topic in order to undertstand the involved phenomena and to develop an creative and correct thinking mode.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Why spectroscopy? Space science based on spectroscopy (Sun, Earth, Mars, Exoplanets). Terminology in spectroscopy. Energy levels, spectral terms, atomic states, wavelength, wavenumber, spectral line, spectral bands, spectral linewidth, continuum spectrum, line spectrum.	Systematic exposition - lecture. Critical analysis. Examples	1 hour
Spectral instruments with dispersion (prism or diffraction grating). Optical components. Spectrographs. Monochromator. Characteristics.	Systematic exposition - lecture. Examples	2 hours
Bohr model of atom. Bohr Postulates and consequences. Spectral series of Hydrogen atom and like Hydrogen atoms. Continuos spectrum of Hydrogen. Correspondence Principle.	Systematic exposition - lecture. Critical analysis. Examples	2 hours
Bohr-Sommerfeld model of atom. Spectral term of fundamental state of atom.	Systematic exposition - lecture. Examples	2 hours
Spectral terms of excitated atoms. Spin-orbit interaction.	Systematic exposition - lecture. Examples	2 hours
Spectra of alkali metal ions.	Systematic exposition - lecture. Examples	2 hours
Zeeman effect. Lorentz theory of normal Zeeman effect. Quantum theory of Zeeman effect.	Systematic exposition - lecture. Examples	2 hours
Applied Spectroscopy in life quality control: food, drinks, health (diagnostics, therapy, drugs), air, soil, water, construction materials, textiles etc.	Systematic exposition - lecture. Examples	1 hour
Laser radiation and its properties. Interaction between radiation and matter. Einstein coefficients. Light propagation in a medium, absorption, diffusion, optical	Systematic exposition - lecture. Critical analysis. Examples	2 hours

gain.		
Conditions for laser operation. First condition of operation – high density of radiation using resonant optical cavity. Finding out of second condition of operation – population inversion using optical pumping. More than two levels necessity for continuous operation. Pumping methods. Optical pumping. Pumping by atomic/molecular collissions. Optical cavity and oscillating modes. Laser amplification. Laser gain. Types of lasers and their characteristics.	Systematic exposition - lecture. Examples	6 hours
Three-level system. Ruby laser. Energy levels, transitions, building up, properties. Four-level system. Advantage versus three-level system. Neodymium laser. Energy levels, transitions, building up, properties.	Systematic exposition - lecture. Examples	2 hours
He-Ne laser. Pumping, Energy levels, transitions, building up, properties.	Systematic exposition - lecture. Examples	2 hours
Ionic lasers. Argon laser. Metallic vapor laser. Molecular lasers. Carbon dioxide laser. Semiconductor laser. Principles of operation, properties.Tunable lasers. Dye laser, excimer laser, color centers laser, semiconductor lasers. Applications of lasers	Systematic exposition - lecture. Examples	2 hours

Bibliography:
1. Iulian Ionita, „Condensed matter optical spectroscopy", CRC Press, 2014.
2. H. E. White, "Introduction to atomic spectra", McGraw-Hill Book Company, New York and London, 1934.
3. M. Csele, „Fundamentals of light sources and lasers" (Wiley, 2004)

8.2. Tutorials	Teaching and learning techniques	Observations
X	X	X

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
Laboratory presentation	Guide activity	2 hours
Prism based spectral instruments	Guided practical activity	2 hours
Difraction gratting based spectral instruments	Guided practical activity	2 hours
Balmer series of Hydrogen atom	Guided practical activity	2 hours
Zeeman effect of Cadmium ion	Guided practical activity	2 hours
Atomic emission spectra obtained by electric arc discharge.	Guided practical activity	2 hours
UV-Vis Spectrophotometry	Guided practical activity	2 hours
Study and alignement of a He-Ne laser	Guided practical activity	2 hours
Analyses and characterization of active media of lasers.	Guided practical activity	2 hours
Study and characterization of diode lasers (808.5 nm)	Guided practical activity	2 hours
Study of solid state laser Nd:YAG	Guided practical activity	2 hours
Analyses of longitudinal modes	Guided practical activity	2 hours
Study of CO2 laser	Guided practical activity	2 hours
Colloquy	Knowledge testing	2 hours

Bibliography:
Laboratory Guides

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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 practical competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, secondary school teaching – National Institute for Laser, Plasma and Radiation Physics., National Institute of Materials Physics, National Institute for Opto-Electronics, IOR, Apel Laser SRL).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	coherence and clarity of exposition - correct use of equations, spectral and laser methods, physical models (Bohr, Zeeman) and theories - ability to indicate/analyse specific examples of practical applications of spectrometry and lasers.	Final written evaluation: Test of theoretical knowledge and applied problems.	50%
		Continue evaluation	20%
		Attendance	10%
10.5.1. Tutorial	X		
10.5.2. Practical	- ability to use specific experimental methods/apparatus (spectrometer, laser, spectral lamp) - Applying specific methods of solving the given problem; - Results interpretation;	Evaluation by practical test	20%
10.5.3. Project	X	X	X
10.6. Minimal requirements for passing the exam Mandatory attendance: 50% from lectures and all practicals completed. At least mark 5 at the end of evaluation.			

Date 29.10.2021	Teacher’s name and signature Assoc. Prof. Ion Gruia Assoc. Prof. Iulian Ionita	Practicals/Tutorials instructor(s) name(s) and signature(s) Assoc. Prof. Ion Gruia Assoc. Prof. Iulian Ionita
Date of approval 11.11.2021		Head of Department Lecturer Dr. Roxana Zus

DI 312F.EN Research Activity

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Research activity							
2.2. Teacher								
2.3. Tutorials/Practicals instructor(s)	Conf.dr. Vasile Bercu							
	3		II		V		Content[1)]	DS

2.4. Year of study		2.5. Semester		2.6. Type of evaluation		2.7. Type of course unit	Type[2)]	DI

[1)] fundamental (DF), speciality (DS), complementary (DC); [2)] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum		distribution: Lecture		Tutorials/ Practicals	
3.2. Total hours per semester	**60**	distribution: Lecture		Tutorials/ Practicals	

Distribution of estimated time for study	hours
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	
3.2.2. Research in library, study of electronic resources, field research	8
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	6
3.2.4. Examination	3
3.2.5. Other activities	

3.3. Total hours of individual study	12
3.4. Total hours per semester	75
3.5. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Cover the courses from the first and the second year
4.2. competences	Knowledge of mathematics, physics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for practicals/tutorials	Laborator

6. Specific competences acquired

Professional competences	C1- Identify and make appropriate use of the main laws and principles of physics, in a given context. C4 – Carry out basic experiments in physics by using specific laboratory equipment. C5 – Analize and communicate basic scientific, educational and popular information on physics.
Transversal competences	CT3- Efficient use of trousted sources of scientific information and profficient communication of scientific data in English

7. Course objectives

7.1. General objective	To present the basic concepts of the field and to familiarize the students with the specific aspect of a research activity
7.2. Specific objectives	- Understandig the specific aspects and the ability to work with different phenomena; - Developing the capacity to work within a research team using laboratory equipment. -Development of experimental skills specific to the field.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Recommended lectures:		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
	Teaching and learning techniques	Observations
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
In agreement with the subject chosen for research activity	Guided practical activity	60 hours
Recommended lectures:		

It is to be specified for the chosen topic, by the supervising teacher and the practice coordinator; includes labor protection rules and initial training seminars for students

8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography:		

9. 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 discipline meets the current requirements for the development of practical skills at national and international level in higher education. The internships will be carried out in the institutes. The companies with which the Faculty of Physics has concluded internship agreements. The targeted fields of activity are multiple, the possible targeted employers being both from the research-development environment and from other fields.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.2 Tutorials			0-100% (if applicable)
10.5.2. Practicals	- evaluation of the experimental skills acquired in the laboratory activity - evaluation of the capacity for analysis and interpretation of experimental results	Internship / activity report	100 %
10.6. Minimal requirements for passing the exam The final examination is conditional on the completion of all planned activities and takes into account the observations / proposals of the practice coordinator.			
Requirements for mark 5 (10 points scale) • Mandatory attendance at all activities included in the internship portfolio • Preparation of the Activity Report, following the internship • Learning the main notions, methods, techniques. Requirements for mark 10 (10 points scale) • Skills, well-argued knowledge • Demonstrated ability to analyze phenomena and processes • Personal approach and interpretation			

Date 05.10.2021	Teacher's name and signature	Practical instructor, name(s) and signature(s) Conf.dr. Vasile BERCU
Date of approval 11.11.2021		Head of Department, Prof.dr. Alexandru Jipa

DI 313F.EN Undergraduate dissertation writing

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Undergraduate dissertation writing							
2.2. Teacher								
2.3. Tutorials/Practicals instructor(s)	Conf.dr. Vasile Bercu							
2.4. Year of study	3	2.5. Semester	II	2.6. Type of evaluation	V	2.7. Type of course unit	Content[1]	DS
							Type[2]	DI

[1] fundamental (DF), speciality (DS), complementary (DC); [2] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum		distribution: Lecture		Tutorials/Practicals	
3.2. Total hours per semester	**60**	distribution: Lecture		Tutorials/Practicals	

Distribution of estimated time for study	hours
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	
3.2.2. Research in library, study of electronic resources, field research	6
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	6
3.2.4. Examination	3
3.2.5. Other activities	

3.3. Total hours of individual study	12
3.4. Total hours per semester	75
3.5. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Cover the courses from the first and the second year
4.2. competences	Knowledge of mathematics, physics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for practicals/tutorials	Laborator

6. Specific competences acquired

Professional competences	C1- Identify and make appropriate use of the main laws and principles of physics, in a given context. C4 – Carry out basic experiments in physics by using specific laboratory equipment. C5 – Analize and communicate basic scientific, educational and popular information on physics.
Transversal competences	CT1 - Carrying out professional tasks efficiently and responsibly in compliance with the legislation of deontology specific to the field under qualified assistance. CT3- Efficient use of trousted sources of scientific information and profficient communication of scientific data in English

7. Course objectives

7.1. General objective	Application in practice of the theoretical knowledge acquired
7.2. Specific objectives	- Understandig the specific aspects and the ability to work with different phenomena; - Developing the capacity to work within a research team using laboratory equipment. -Development of experimental skills specific to the field.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Recommended lectures:		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
	Teaching and learning techniques	Observations

8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
In agreement with the subject chosen for research activity	Guided practical activity	60 hours
Recommended lectures: It is to be specified for the chosen topic, by the supervising teacher and the practice coordinator; includes labor protection rules and initial training seminars for students		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography:		

9. 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 discipline meets the current requirements for the development of practical skills at national and international level in higher education. The internships will be carried out in the institutes. The companies with which the Faculty of Physics has concluded internship agreements. The targeted fields of activity are multiple, the possible targeted employers being both from the research-development environment and from other fields.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.2 Tutorials			0-100% (if applicable)
10.5.2. Practicals	- evaluation of the experimental skills acquired in the laboratory activity - evaluation of the capacity for analysis and interpretation of experimental results	Internship / activity report	100 %
10.6. Minimal requirements for passing the exam The final examination is conditional on the completion of all planned activities and takes into account the observations / proposals of the practice coordinator.			
Requirements for mark 5 (10 points scale) • Mandatory attendance at all activities included in the internship portfolio • Preparation of the dissertation thesis Requirements for mark 10 (10 points scale) • Skills, well-argued knowledge • Demonstrated ability to analyze phenomena and processes • Personal approach and interpretation			

Date 05.10.2021	Teacher’s name and signature	Practical instructor, name(s) and signature(s) Conf.dr. Vasile BERCU
Date of approval 11.11.2021		Head of Department, Prof.dr. Alexandru Jipa

Elective courses

DO.105F.1.EN Computer programming (C/C++)

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Structure of Matter, Physics of Earth. And Atmosphere, Astrophysics

1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Computer programming (C/C++)								
2.2. Teacher				Lect. Univ. Dr. Marius Călin					
2.3. Tutorials/Practicals instructor(s)				Lect. Univ. Dr. Marius Călin					
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	C	2.7. Classification of course unit	Content 1)	DC	
							Type 2)	DO	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	1	Tutorials	0	Practicals	2	Project 0
3.2. Total hours per semester	42	distribution:	Lectures	14	Tutorials	0	Practicals	28	Project 0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	25
3.3.2. Research in library, study of electronic resources, field research	20
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	9
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	54
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competencies	High school mathematics, fundamental algorithms

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Video projector
5.2. for practicals/tutorials/projects	Computer room

6. Specific competences acquired

Professional competencies	– Using of dedicated software for data analysis and processing - Solving physics problems in given conditions, using numerical and statistical methods – Presenting and analyzing information of didactics, scientific and outreach in physics – Interdisciplinary approach of some physics problems
Transversal competencies	- Efficient use of information and communication resources available.

7. Course objectives

7.1. General objective	Getting acquitted with computer programming basics, especially with C/C++ programming language. Developing algorithms for solving physical problems.
7.2. Specific objectives	- knowledge of programming language specifics; physical theories/models - developing the ability of modeling and solving physical problems; - using the computing skills for experimental and theoretical applications

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
- Hardware. Computer architecture. Binary system.	Systematic exposition -	1 hour

- Software. Operation systems and programming languages. Short history. - Correlation between the scientific coding language and the solving problem type: model calculations, simulation, data acquisition and processing. Examples of complex codes. - Scientific languages mostly used in physics: evolution, general characteristics, distinctive features	lecture.	
- Programming stages: problem solving, developing algorithm, implementation, compilation, execution. - Structure of a C++ program - Preprocessor directives, headers, libraries - Input/output	Systematic exposition - lecture. Examples	1 hour
- Variable types. Constants. - Operators: arithmetic, relational and comparison, logical, assignment, conditional, sizeof, dot (.), arrow (- >), increment and decrement, etc.	Systematic exposition - lecture. Examples	1 hour
- Control structures: * selection statements:: if – else, switch * iteration statements (loops): while, do – while, for jump statements: continue, break, goto, etc. - Functions: types, declaring, prototypes, calling	Systematic exposition - lecture. Examples	1 hour
- Arrays: initializing, accessing the values using references and pointers - Reference and dereference operators - Strings, operations with strings	Systematic exposition - lecture. Examples	1 hour
- Pointers: declaring pointers, operations, comparison - Ponters and references	Systematic exposition - lecture. Examples	2 hours
- Dynamic memory: operators new, delete - Data structures	Systematic exposition - lecture. Examples	2 hours
- Classes: definition, objects, constructors, deconstructors, initialization, access to members, copy and move constructors	Systematic exposition - lecture. Examples	2 hours
- Object Oriented Programming (OOP). Characteristics: encapsulation, inheritance, polymorphism	Systematic exposition - lecture. Examples	2 hours
- Analysis of complex codes written in C++: Root, GEANT4	Systematic exposition - lecture. Examples	1 hour

Bibliography:

Bibliography:
1. Bjarne Stroustrup – Principles and Practice Using C++ - Addison – Wesley Publishing Company, 2009
2 Bjarne Stroustrup – The Design and Evolution of C++, - Addison – Wesley Publishing Company, 1994
3. R. Andonie, I. Gârbacea – Algoritmi fundamentali, o perspectivă C++ - Editura Libris, Cluj –Napoca, 1995
4. M. Hjorth-Jensen – Computational Physics, Universitatea din Oslo, note de curs, 2012
5. https://isocpp.org
6. www.cplusplus.com
7. www.learncpp.com
8. http://www.stroustrup.com

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
Basic statements in C and C++. Applying the sequence Edit-Compile-Link-Run for C++ codes in operation system Linux	Guided practical activity	2 hours
Developing codes including different types of variables, operators, control structures, preprocessor directives, functions	Guided practical activity	4 hours
Developing codes including arrays, strings, pointers	Guided practical activity	4 hours

Developing codes which use dynamic memory and data structures,classes	Guided practical activity	4 hours
Developing codes emphasizing the advanteges of OOP	Guided practical activity	4 hours
Random number generation and applications	Guided practical activity	2 hours
Plotting with GnuPlot. Input/output from files	Guided practical activity	2 hours
Performance analysis and optimization	Guided practical activity	4 hours
The structure of complex codes. Comparison between C++ and the latest versions of Fortran	Guided practical activity	2 hours
Bibliography: Bibliography: 1. Bjarne Stroustrup, Programming, Principles and Practice Using C++, Addison-Wesley Publishing, 2008 2. Bjarne Stroustrup, The Design and Evolution of C++, Addison-Wesley Publishing Company, 1994 3. https://isocpp.org		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 practical competences and abilities which are fundamental for an undergraduate student in the field of modern Physics, corresponding to national and European/international standards. 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/expectations of the main employers of the graduates (economy, research, education).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- knowledge, understanding, coherence, logic and clarity of exposition	Written test	45%
10.5.1. Tutorial			
10.5.2. Practical	- ability to model a problem, create an algorithm, implement it into a functional code	Computer code	55%
10.5.3. Project			
10.6. Minimal requirements for passing the exam Participation to all practical activities and at least 7 lectures - Solving 25% of the written test. - Developing and presenting a code with a low degree of complexity but fully functional. 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 10.10.2021	Teacher’s name and signature Lect. Univ. Dr. Marius Călin	Practicals/Tutorials instructor(s) name(s) and signature(s) Lect. Univ. Dr. Marius Călin

Date of approval
11.11.2021

Head of Department
Prof. Univ. Dr. Alexandru Jipa

DO.105F.2.EN Physical Chemistry

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title		Physical Chemistry							
2.2. Teacher				Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu					
2.3. Tutorials/Practicals instructor(s)				Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu					
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	C	2.7. Classification of course unit	Content 1)	DC	
							Type 2)	DO	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	1	Tutorials		Practicals	2	Project
3.2. Total hours per semester	42	distribution:	Lectures	14	Tutorials		Practicals	28	Project

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	18
3.3.2. Research in library, study of electronic resources, field research	15
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	21
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	54
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC), Internet access
5.2. for practicals/tutorials/projects	Laboratory rooms equipped with: • Modern equipment, instruments and accessories: modern laboratory glassware; Sartorius analytical balance; Analytical balance Kern ABS 220-4N, 220g; Kern precision scales; pipettes; micropipettes; manual and electronic pipetting devices; magnetic stirrers with and without heating; computers; mechanical stirrer (VIBRAX stirrer); pH-meters (stationary: Fisher Scientific; portable: pH 110 Exstik); Conductometer 3110 WTW; ovens with thermostat and electronic display; water purification system Milli-Q (conductivity ≤ 0.1 µS cm^{-1}); Titan probe sonicator Hielscher UP 100H; Ultrasonic bath BRANSON 1210; Water bath with electronic display and recirculation; SIGMA 2-16 K cooling centrifuge; spectrophotometers; UV-Vis single-beam spectrophotometer (model UV-20) ONDA; Temperature sensor with electronic display; Fisher Scientific Vortex Agitator, 1500 rpm; Ostwald viscometer; specific reagents; refrigerator;

	high-performance air conditioners, etc. • Interactive practical laboratory equipment - Phywe experimental set-up, computer assisted. • Computers with internet connection, tables, video projector, screen, blackboard.

6. Specific competences acquired

Professional competences	Identification and correct use of physical laws and principles in given contexts. Analysis and communication/presentation of scientific data. Interdisciplinary approach of topics in physics.
Transversal competences	Efficient use of the sources of scientific information and communication of scientific data in English

7. Course objectives

7.1. General objective	Understanding the notions related to the composition, physico-chemical properties and transformations of matter, as well as the energy involved in these transformations.
7.2. Specific objectives	Knowledge of specific physical theories and models used in physical chemistry; Using the acquired knowledge to solve specific problems in physical chemistry; performing and interpretation of experiments. Understanding the dynamics of chemical processes, factors that influence the reaction rate; calculation of the kinetic parameters. Calculation the amount of heat released / necessary to conduct a chemical reaction. Predict the outcome of chemical reactions based on thermodynamic parameters. Getting information about material properties from phase diagrams. Calculation of the equilibrium compositions and equilibrium constants. Understanding the basic concepts in electrochemistry.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Introduction to physical chemistry (main physical chemistry subjects; tangent with other disciplines; general notions).	Systematic exposition – lecture; interactive presentation. Examples. Applications	1 hour
Chemical Thermodynamics. (Types of systems. Thermodynamic parameters. The laws of thermodynamics. Thermochemistry. Equations Gibbs - Helmholtz. Chemical potentials.)	Systematic exposition – lecture; interactive presentation. Examples. Applications	2 hours
Phase equilibrium (basics; phase diagram; ideal and real solutions)	Systematic exposition – lecture; interactive presentation. Examples. Applications	1 hour
Chemical equilibrium (Law of mass action for chemically homogeneous and heterogeneous equilibrium. Equilibrium constants)	Systematic exposition – lecture; interactive presentation. Examples. Applications	2 hours
Chemical kinetics (Fundamentals. Reaction rate. Reaction order. Reaction mechanisms. Arrhenius equation)	Systematic exposition – lecture; interactive presentation. Examples. Applications	3 hours
Electrochemistry (Specific and equivalent electrical conductivity of electrolyte solutions and their dependence on solution dilution. Conductometric method for determining the degree and constant of ionization of weak electrolytes, and the conductivity coefficient of strong electrolytes. Electrode potentials. The mechanism of the appearance of the electric double layer. Nernst equation for electrode potential. Electrode classification. Standard hydrogen electrode. Galvanic cells. Dependence of electromotive force on the electrolyte concentration. Electrochemical cells.	Systematic exposition – lecture; interactive presentation. Examples. Applications	5 hours

<table>
<tr><td>Potentiometry. pH. Electrolysis and its applications)</td><td></td><td></td></tr>
<tr><td colspan="3">Bibliography:
▪ Neniţescu, C. D., Chimie generală, Editura Didactică şi Pedagogică, Bucureşti, 1978
▪ Linus Pauling, Chimie generală, Editura Ştiinţifică, Bucureşti, 1988
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▪ T. W. Shattuck, Physical Chemistry, Colby College, 2015.
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▪ K. A. Dill, S. Bromberg, Molecular Driving Forces: Statistical Thermodynamics in Chemistry and
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▪ K. L. Kapoor, A Textbook of Physical Chemistry, McGraw Hill Education (India) Private Limited, 2015.
▪ Irina Zgura, Nicoleta Preda, Monica Enculescu, Lucian Diamandescu, Catalin Negrila, Mihaela Bacalum, Camelia Ungureanu, Marcela Elisabeta Barbinta-Patrascu, Cytotoxicity, Antioxidant, Antibacterial, and Photocatalytic Activities of ZnO–CdS Powders, Materials 13(1), 182, 2020;</td></tr>
<tr><td>8.2. Tutorials</td><td>Teaching and learning techniques</td><td>Observations</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Bibliography:</td></tr>
<tr><td>8.3. Practicals</td><td>Teaching and learning techniques</td><td>Observations</td></tr>
<tr><td>Instructions for safety and health at work for activities in physical chemistry lab. Familiarization with laboratory equipment and accessories.</td><td>Systematic exposition - lecture. Conversations. Examples</td><td>2 hours</td></tr>
<tr><td>Types of concentrations; measurement units. Solving problems. Preparation of solutions of a certain concentration. Successive dilutions.</td><td>Systematic exposition - lecture. Conversations. Examples. Applications.
Guided practical activity</td><td>4 hours</td></tr>
<tr><td>Determination of the viscosity of liquids</td><td>Guided practical activity</td><td>2 hours</td></tr>
<tr><td>Acetic acid adsorption on activated carbon. Determination of the adsorption isotherm.</td><td>Guided practical activity</td><td>4 hours</td></tr>
<tr><td>Determination of dissociation constant of electrolyte solutions</td><td>Guided practical activity</td><td>2 hours</td></tr>
<tr><td>Chemical equilibrium. Le Chatelier's Principle</td><td>Guided practical activity</td><td>2 hours</td></tr>
<tr><td>The reaction kinetics of the reduction of methylene blue with ascorbic acid</td><td>Guided practical activity</td><td>2 hours</td></tr>
<tr><td>Determination of Activation Energy</td><td>Guided practical activity</td><td>2 hours</td></tr>
<tr><td>Electromotive force of the Daniell-Jacobi cell</td><td>Guided practical activity</td><td>4 hours</td></tr>
<tr><td>Discussing laboratory reports. Solving problems and tests of physical chemistry</td><td>Systematic exposition - lecture. Conversations. Examples. Applications.</td><td>4 hours</td></tr>
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▪ Parotă, A., Vasile, A. D., Probleme de chimie aplicată, vol. 1, Editura Tehnică, Bucureşti, 1988
▪ András Kiss, Lívia Nagy, Géza Nagy, Barna Kovács, Beáta Peles-Lemli, Sándor Kunsági-Máté (Eds.), Manual for Physical Chemistry Laboratory (Experiments for Undergraduate Students), 2014.
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http://www.homepages.dsu.edu/bleilr/npmanual.pdf http://ocw.mit.edu/courses/chemistry/5-301-chemistry-laboratory-techniques-january-iap-2012/labs/MIT5_301IAP12_comp_manual.pdf

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 aims at developing specific theoretical and practical competences and abilities in the field of Physical Chemistry, corresponding to national and european/international standards. 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 (Babes-Bolyai University, Cluj-Napoca) or from abroad (The University of British Columbia; University of Coimbra; University of California Los Angeles UCLA; Colby College; McGill University; University College London; Washington State University). The content of the discipline is in accordance with the requirements for employment in research institutes in physics, materials science and education (in accordance with the law).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/and theories - ability to indicate/analyse specific examples	Written test	60%
10.5.1. Tutorial			
10.5.2. Practical	- Ability to perform specific experiments; ability to handle equipment, chemical reagents and laboratory utensils; - Application of specific methods for solving problems and tests of physical chemistry; - Correct processing and interpretation of experimental results.	Continuous evaluation; Lab reports; practical evaluation	40%
10.5.3. Project			
10.6. Minimal requirements for passing the exam Attendance at least 50% of the number of lectures and compulsory attendance at all laboratory sessions. Completion of all work and laboratory reports. Correct solution for the subjects indicated to obtain score 5 at the final colloquium.			

Date 4.11.2021	Teacher's name and signature Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu	Practicals/Tutorials instructor(s) name(s) and signature(s) Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu

Date of approval
11.11.2021

Head of Department
Assoc.Prof.Dr. Adrian Radu

DO.106F.1.EN Ethics and academic integrity

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	The Structure of Matter, the Physics of the Atmosphere and the Earth, Astrophysics
1.4. Field of study	Physics

1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Ethics and academic integrity**							
2.2. Teacher			Lecturer PhD Sanda Voinea					
2.3. Tutorials/Practicals instructor(s)								
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	C	2.7. Type of course unit	Content [1)]	DC
							Type [2)]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	1	Tutorials	0	Practicals	0	Project	0
3.2. Total hours per semester	14	distribution:	Lectures	14	Tutorials	0	Practicals	0	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	8
3.3.2. Research in library, study of electronic resources, field research	12
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	12
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	32
3.5. Total hours per semester	50
3.6. ECTS	2

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia room
5.2. for practicals/tutorials/projects	

6. Specific competences acquired

Professional competences	Understanding and acquiring the skills characteristic of an integrity physicist, understanding and using the practices that characterize the scientific and academic community.
Transversal competences	Understanding the importance of academic integrity for the functioning of society

7. Course objectives

7.1. General objective	Development of moral thinking and integration of students in the ethical culture of the university.
7.2. Specific objectives	Integration of scientific research into the moral culture, Consolidation of autonomy in the moral decision, Internalization of good practices of intellectual conduct.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations

Moral evaluation frameworks. How do we analyze an ethical issue? Fundamental concepts of ethics. Ethics and the scientific community. Criteria for moral evaluation: consequences / intentions, virtues. Systematic exposition - lecture. Example. Discussion.	Lecture. Example. Discussion.	2 hours
Academic integrity: institutional tools. Codes and ethics commissions. The virtues of an integral academic organization. Ethical evaluation and endorsement of research projects: why it is necessary and how it is done. UB's ethical culture. Who do we turn to solve a moral problem?	Lecture. Example. Discussion.	2 hours
The specifics of academic ethics. Research ethics, professional ethics. Immoral behaviors in academic organizations (typology and consequences). Ethics and academic performance.	Lecture. Example. Discussion.	2 hours
Principles of research ethics. Academic freedom and disagreement in science. Precautionary principle and risky research (e.g.with dual use). Informed consent and respect for autonomy. Challenges and dilemmas in research ethics.	Lecture. Example. Discussion.	2 hours
Plagiarism and self-plagiarism. Falsification or fabrication of research results. Originality of results Ethics of publication: author and co-author. Access to resources (justice and equity in academic organizations and research teams). Deontology of teamwork in scientific research. Implications and results of collaboration. Respect for intellectual property. Copyright. Academic writing. How to write an academic paper.	Lecture. Example. Discussion.	6 hours

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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
A. Avram, C. Berlic, B. Murgescu, Mirela Luminița Murgescu, M. Popescu, Cosima Rughiniș, D. Sandu, E. Socaciu, Emilia Șercan, B. Ștefănescu, Simina Elena Tănăsescu, Sanda Voinea, Coordonator L. Papadima, "Deontologie academică. Curriculum-cadru", Editura Universitatii din București, 2017.
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Bretag, T. *(ed), Handbook of Academic Integrity, Singapore: Springer, 2016*
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De George, R., T., Academic Freedom and Tenure: Ethical Issues, Oxford: Rowman & Littlefield Publishers, 1997

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 impact implications. The content of the course is consistent with the content of similar courses taught at universities in the country (Babeş-Bolyai University, Cluj Napoca, "Alexandru Ioan Cuza" University of Iasi) and major universities abroad, providing students with tools for moral decision and ethics that can be used by students in their academic activity and in their professional life.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	Originality Critical spirit Academic writing Knowledge of the rules of academic ethics	On-going evaluation (individual or team topics). Elaboration of an essay with a topic presented in the course	20% 80%
10.5.1. Tutorial			
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam Complete solving of the subjects indicated for obtaining the ADMITTED qualifier.			

Date	Teacher's name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
11.10.2021	Lecturer Sanda Voinea	

Date of approval
11.11.2021

Head of Department
Professor PhD Alexandru Jipa

DO.106F.2.EN. Authoring and scientific dissemination

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

<table>
<tr><td colspan="3">2.1. Course unit title</td><td colspan="8">Authoring and scientific dissemination</td></tr>
<tr><td colspan="5">2.2. Teacher</td><td colspan="6">Conf. Dr. Necula Cristian Constantin</td></tr>
<tr><td colspan="5">2.3. Tutorials/Practicals instructor(s)</td><td colspan="6">-</td></tr>
<tr><td rowspan="2">2.4. Year of study</td><td rowspan="2">1st</td><td rowspan="2">2.5. Semester</td><td rowspan="2">1</td><td rowspan="2">2.6. Type of evaluation</td><td rowspan="2">C</td><td rowspan="2">2.7. Classification of course unit</td><td>Content 1)</td><td>DC</td></tr>
<tr><td>Type 2)</td><td>DO</td></tr>
</table>

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	1	distribution:	Lectures	1	Tutorials	-	Practicals	-	Project	-
3.2. Total hours per semester	14	distribution:	Lectures	14	Tutorials	-	Practicals	-	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	16
3.3.2. Research in library, study of electronic resources, field research	16
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	-
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	32
3.5. Total hours per semester	50
3.6. ECTS	2

4. Prerequisites (if necessary)

4.1. curriculum	Any/All of courses contained in the curriculum
4.2. competencies	Ability to work with Microsoft Office or equivalent package.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Classroom supplied with a projector
5.2. for practicals/tutorials/projects	-

6. Specific competences acquired

Professional competencies	C1: Properly identification and application of the main problems of the authoring and scientific writing in a given context. C1.1: Description and recognition of structure of a scientific paper/book/conference comunication using specific criteria. C1.2: Correct application of the scientific writing methods to fulfill the specified tasks. C3: Solving authorship and scientific writing and presentation problems in given conditions using specific technique. C3.1 Properly application of the scientific writing methods for elaboration of different scientific dissemination (e.g. writing a short scientific communication). C3.3 Correlation between scientific writing methods and the specified particular problems appearing in scientific dissemination and authorship. C3.4 Evaluation of the results and comparison to literature example C4. Application of the knowledge acquired from scientific writing in concrete situations from various Physics domains. C6: Interdisciplinary approach of several Physics subjects C6.1: Making connections necessary to application of scientific writing using basic knowledge from different Physics subjects C6.4: Making connections between different Physics disciplines and possibly other related domains.
Transversal competencies	CT2: Efficient work techniques application in multidisciplinary team on various hierarchical levels. CT3: Efficient usage of information, communication resources and assisted training.

7. Course objectives

7.1. General objective	Fundamental concepts presentation related to write and publish a successful scientific work.
7.2. Specific objectives	Understanding the specific aspects regarding the elaboration of any scientific publication such as a scientific paper, chapter book/book, poster preparation, oral presentations etc.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Introduction. Definition of scientific writing. The aim(s) for writing a scientific paper. How to plan a research and choose a paper topic. Literature search and state of the art.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
2. The standard structure of a scientific paper. Abstract, Introduction, Method, results and discussions, conclusions. Example of paper from Journal of Geophysical Research.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
3. Language and style of a scientific paper. Using abbreviations. Preparing the Figures and Tables. The quality of a figure. Examples of Figures and Tables.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
4. Preparing the Abstract and Title. References and citation of them in the main manuscript. Acknowledgments. Copyright considerations.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
5. Publication process. Choosing the appropriate journal. Submitting process. Cover letter. The review process. Accept, modify, reject letters.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
6. Authorship definition. Authors contributions. Author order. Acknowledgments again. Plagiarism. Authors responsibilities before publication, during peer review process and after publication	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
7. Other scientific writing. Writing a review paper. Writing a book chapter/ book. Writing a conference report. Preparing a poster. Presenting a work orally in a conference meeting.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours

Bibliography:
1. Chris A. Mack, 2018, How to Write a Good Scientific Paper, SPIE PRESS, Bellingham, Washington USA, 124 pp.
2. Barbara Gastel and Robert A. Day, 2016, How to Write and Publish a Scientific Paper, Greenwood, Santa Barbara, California, USA, 346 pp.
3. S. R. N. Reis, A. I. Reis, 2013, How to Write Your First Scientific Paper, DOI: 10.1109/IED**EC.2013.6526784.**

9. 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 forms/develops theoretical and practical competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of scientific writing methods and concepts - ability to apply to specific examples	oral examination	100%
10.5.1. Tutorial	-	-	-
10.5.2. Practical	-	-	-
10.5.3. Project	-	-	-

10.6. Minimal requirements for passing the exam Participating to minimum 50% of the lectures. Requirements for mark 5 (10 points scale) Correct understanding of the main concepts and methods of authoring and scientific dissemination and ability to use them on given particular situations.

Date 2.11.2021	Teacher’s name and signature Necula Cristian Constantin	Practicals/Tutorials instructor(s) name(s) and signature(s) -
Date of approval 11.11.2021	Head of Department Prof.dr. Alexandru Jipa	

DO.205F.1.EN Simulation Methods in Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Simulation Methods in Physics								
2.2. Teacher				Conf.dr. Alexandru NICOLIN, Lect.dr. Roxana ZUS					
2.3. Tutorials/Practicals instructor(s)				Conf.dr. Alexandru NICOLIN, Lect.dr. Roxana ZUS					
2.4. Year of study	II	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1)]	DS	
							Type[2)]	DO	

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	1	Tutorials	0	Practicals	1	Project 1
3.2. Total hours per semester	42	distribution:	Lectures	14	Tutorials	0	Practicals	14	Project 14

Distribution of estimated time for study	hours
3.2.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	25
3.2.2. Research in library, study of electronic resources, field research	20
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	34
3.2.4. Examination	4
3.2.5. Other activities	

3.3. Total hours of individual study	79
3.4. Total hours per semester	125
3.5. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Programming Languages, Algebra, Analysis, Differential Equations
4.2. competences	Knowledge of programming, linear algebra, analysis, differential equations

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Computer, Video projector Lecture notes

	Bibliography
5.2. for practicals/tutorials	Computer network Lecture notes Bibliography

6. Specific competences acquired

Professional competences	- Identifying and using the right physical laws and principles in given conditions - Using of dedicated software for data analysis and processing. - Solving physics problems in given conditions, using numerical and statistical methods.
Transversal competences	- Performing professional tasks in an efficient and responsible manner in compliance with the legislation and deontology specific to the field under qualified assistance. - Effective use of information sources, communication and training resources in a foreign language.

7. Course objectives

7.1. General objective	Learning techniques of numerical simulation for solving of problems and data analysis
7.2. Specific objectives	- Understanding specific problematic and correlation between analytic and applicative aspects; - Developing abilities for numerical simulation; - Developing abilities for adapting numerical algorithms to physics problems; - Developing abilities for data analysis and interpretation from numerical estimations and to formulate rigorous theoretical conclusions.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
1. Modeling and simulation of physical systems Fundamental concepts - system; the structure of systems modeling and simulation; measurement and experimental data processing. Linear systems in physics - OTF and PSF. Linear prediction - Fourier transform, convolution and de-convolution signals. Modeling and simulation in contemporary knowledge.	Systematic exposition - lecture. Critical analysis. Examples	4 hours
2. Theory of modeling and simulation Basic concepts; specification systems formalism. Formalisms of modelling and their simulators: DT (Discrete Time); DEQ (Differential Equation); DEV (Discrete Event); Verification, Validation, Approximate morphisms. Complexity theory.	Systematic exposition - lecture. Critical analysis. Examples	4 hours
3. Ordinary Differential Equations (ODE) Modeling with ODE. Geometric meaning of the solutions of differential equations. Solutions of differential equations. Finite differences. Cellular automata. Nonlinear physical systems - Phase space, maps and flows, autonomous and non-autonomous systems; deterministic chaotic systems. Applications in physics.	Systematic exposition - lecture. Critical analysis. Examples	4 hours
4. Monte Carlo simulation methods Applications in physics	Systematic exposition - lecture. Critical analysis. Examples	4 hours
5. Partial Differential Equations Finite difference methods; Spectral methods; Relaxation methods**;** Applications in physics: heat equation, diffusion, Navier-Stokes etc.	Systematic exposition - lecture. Critical analysis. Examples	6 hours
6. Presenting sample problems from physics (mechanics, thermodynamics, electromagnetics, atomic physics etc.) for project	Systematic exposition - lecture. Case study. Examples	2 hours

7. Integral Equations Fredholm Equations, Volterra Equations, Integro-Differential Equations, Inverse problems	Systematic exposition - lecture. Examples	4 hours

Bibliography:
- Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, „Theory of Modeling and Simulation”, Academic Press (2000);
- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, “Numerical Recipes: The Art of Scientific Computing”, 3rd ed.,Cambridge University Press, 2007
- R. Burden, J. D. Faires, "Numerical Analysis", Thomson Brooks/Cole, 2010- George W. Collins , “Fundamental Methods and Data Analysis”, 2003
- Morten Hjorth-Jensen , “Computational Physics”, University of Oslo, 2006
- Sheldon M. Ross, “Simulation”, Academic Press (2002)
- Stephen Wolfram, A New Kind of Science (http://www.wolframscience.com/nksonline/toc.html)
- Roxana Zus, Lecture notes in electronic format- barutu.fizica.unibuc.ro/~ftmopl

8.2. Tutorials [main themes]	Teaching and learning techniques	Observations

8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
Environment for programming the numerical and simulation methods exposed in the lecture	Systematic exposition. Heuristic conversation. Guided practical activity	1 hours
Modeling, simulation and prediction of physical systems: DES (Differential Equation System); DTS (Discrete Time System); Devs (Discrete Event System). Applications in physics.	Guided practical activity	4 hours
Programming the methods for numerical solution of ordinary differential equations. Applications in physics.	Guided practical activity	4 hours
Programming the methods for numerical solution of partial differential equations. Applications in physics.	Guided practical activity	3 hours
Programming the methods for numerical solution of integral equations. Applications in physics.	Guided practical activity	2 hours

Bibliography:
- Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, „Theory of Modeling and Simulation”, Academic Press (2000);
- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, “Numerical Recipes: The Art of Scientific Computing”, 3rd ed.,Cambridge University Press, 2007
- R. Burden, J. D. Faires, "Numerical Analysis", Thomson Brooks/Cole, 2010- George W. Collins , “Fundamental Methods and Data Analysis”, 2003
- Morten Hjorth-Jensen , “Computational Physics”, University of Oslo, 2006
- Sheldon M. Ross, “Simulation”, Academic Press (2002)
- Stephen Wolfram, A New Kind of Science (http://www.wolframscience.com/nksonline/toc.html)
-Kendall Atkinson, “The Numerical Solution of Integral Equations of the Second Kind “, Cambridge Univ. Press, 1997
- P.K. Kythe , M.R. Shaferkotter, “Handbook of Computational Methods for Integration”, Chapman & Hall, CRC Press, 2005
- Mircea Bulinski, “Modelare si simulare – Aplicatii in OSPL”, Ed. Universitatii Bucuresti, 2011
- Roxana Zus, course notes in electronic format - barutu.fizica.unibuc.ro/~ftmopl
- Roxana Zus, Adrian Stoica, laboratory notes in electronic format - barutu.fizica.unibuc.ro/~ftmopl

8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Monte-Carlo simulation. Applications in physics.	Guided practical activity	4 hours
Linear systems in physics. Linear prediction. Applications in physics.	Guided practical activity	4 hours
Nonlinear systems in physics. Time-series analysis. Analysis of phase space. Applications in physics.	Guided practical activity	4 hours
Stochastic and deterministic modeling of complex systems. Applications in physics.	Guided practical activity	2 hours

Bibliografie:
- Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, „Theory of Modeling and Simulation”, Academic Press (2000);
- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, “Numerical Recipes: The Art of Scientific Computing”, 3rd ed.,Cambridge University Press, 2007

- Morten Hjorth-Jensen , “Computational Physics”, University of Oslo, 2006 - Sheldon M. Ross, “Simulation”, Academic Press (2002) - Mircea Bulinski, “Modelare si simulare – Aplicatii in OSPL”, Ed. Universitatii Bucuresti, 2011

9. 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)

For the elaboration of the contents, of the teaching and learning methods, the teachers have consulted the corresponding lectures from national and international universities. The content is in agreement with the research topics of the R&D institutes that use numerical methods for solving specific problems, simulations and/or processing of physical data.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of methods - ability to indicate/analyse specific examples	Written test and oral examination	25%
10.5.1. Tutorials			
10.5.2. Practicals	- ability to apply specific methods for given problems - ability to present and discuss the results	Evaluation through practical activity	25%
10.5.3. Project [only if included in syllabus]	- ability to apply the redactation techniques in solving the given physics problem - ability to present the methods and techniques used - the project presentation	Evaluation through practical activity.	50%
10.6. Minimal requirements for passing the exam			
Requirements for mark 5 (10 points scale) Minimum attendance: 50% lecture, 75% applied activities (practicals and project). Correct exposition of 50% from the theoretical topics at the final exam. Correct numerical solution of one problem at the final exam.			

Date 06.11.2021	Teacher’s name and signature Conf.dr. Alexandru NICOLIN Lect.dr. Roxana ZUS	Practicals/Tutorials instructor(s) name(s) and signature(s) Conf.dr. Alexandru NICOLIN Lect.dr. Roxana ZUS

Date of approval
11.11.2021

Head of Department
Lect.dr. Roxana ZUS

DO.205F.2.EN Systems theory

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solod state and Biophysics
1.4.Field of study	Physics
1.5.Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Systems Theory

2.2. Teacher				Conf. dr. Mihai Dinca					
2.3. Tutorials/Practicals instructor(s)				Conf. dr. Mihai Dinca					
2.4. Year of study	2	2.5. Semester	3	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	1	Tutorials		Practicals	2	Project	
3.2. Total hours per semester	42	distribution:	Lectures	14	Tutorials		Practicals	28	Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	25
3.3.2. Research in library, study of electronic resources, field research	25
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	29
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	79
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Calculus
4.2. competencies	IT compentences

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Teaching hall, LCD projector
5.2. for practicals/tutorials/projects	Computers, laboratory

6. Specific competences acquired

Professional competencies	Using of dedicated software for data analysis and processing. Carry out basic experiments in physics by using specific laboratory equipment.
Transversal competencies	Applying the techniques of effective multidisciplinary team working on various hierarchical levels. Efficient use of information and communication resources available.

7. Course objectives

7.1. General objective	Introduction in System Theory, focused on control systems
7.2. Specific objectives	- Ability to modeland simulate continuous time and discrete time systems. - Stability analysis for controlsystems - Controller design - Performance assesment for control systems

8. Contents

8.1. Lectures[chapters]	Teaching techniques	Observations
Systematic exposition	lecture. Heuristic conversation. Critical analysis. Examples	2 hours
Signals and systems. Definition, classification. Operations with signals. System models.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
State variable models	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
Characteristics of Feedback control systems	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
Performances of Feedback control systems	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
Stability of Feedback control systems	Systematic exposition - lecture. Heuristic	1 hour

	conversation. Critical analysis. Examples	
Root locus	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
Stability in the frequency domain	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
Methods of control systems design	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours
Design of the state feedback systems	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	1 hour
Discrete time control systems	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 hours

Bibliography:

1. A. Oppenheim, Signals and systems, Prentice-Hall, 1997
2. Richard C. Dorf and Robert H. Bishop, Modern control systems, 12th ed., Pearson Education, Inc, 2011
3. G. Franklin, D. Powell, M. Workman, Digital control of dynamic systems, Ellis Kagle Press, 1998.
4. K. Astrom and T. Hagglund, PID controllers, 2nd ed, Instruments Society of America, 1995.
5. B. Kuo, Automatic control systems, Prentice Hall Inc. 1975
6. Mihai P. Dinca, Complemente de Electronica, Editura Universitatii din Bucuresti, 2000.
7. Adriana Teodorescu – Teoria sistemelor automate, Editura Politehnica, Timişoara, 2003

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
Modeling of linear systems. Conversion between different representations	Group working using a dedicated software (Labview, Octave)	2 hours
The efeect on the poles and zeros location on the transient response of a SISO LTI system	Group working using a dedicated software (Labview, Octave)	4 hours
The efeect on the poles and zeros location on the frequency response of a SISO LTI system.	Group working using a dedicated software (Labview, Octave)	4 hours
The root locus method	Group working using a dedicated software (Labview, Octave)	4 hours
Stability study in the frequency domain	Group working using a dedicated software (Labview, Octave)	2 hours
System identification applied to an existing physical system (temperature control using Peltier thermoelectric modules)	Group working using a dedicated software (Labview, Octave)	2 hours
Design and implementation of a PID controller for the temperature control system	Group working using a dedicated software (Labview, Octave)	4 hours
Performance assesment for the realized temperature control system	Group working using a dedicated software (Labview, Octave)	6 hours

Bibliography:

N. Nise Control systems engineering, Willey 2004
Astrom and T. Hagglund, PID controllers, 2nd ed, Instruments Society of America, 1995.

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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 forms/develops competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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 United States. Following one of the most succesfull textbook (Dorf & Bishop) , the contents are in line with the requirements/expectations of the main employers of the graduates (industry, research, secondary school teaching

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Written test	75%
10.5.1. Tutorial			
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Lab reports, continuos assesment	25%
10.5.3. Project			
10.6. Minimal requirements for passing the exam All practical activities must be finalized, At least 5.0 poins (out of 10) for both written test and laboratory activities.			

Date
8.11.2021

Teacher's name and signature
Assoc. Prof. Mihai Dinca

Practicals/Tutorials instructor(s) name(s) and signature(s)
Assoc. Prof. Mihai Dinca

Date of approval
11.11.2021

Head of Department
Assoc. Prof. Adrian Radu

DO.213F.1.EN 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	Physics
1.5.Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Virtual instrumentation and data acquisition							
2.2. Teacher			Assoc. Prof. Adrian RADU					
2.3. Tutorials/Practicals instructor(s)			Assoc. Prof. Adrian RADU					
2.4. Year of study	2	2.5. Semester	4	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DS
							Type 2)	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Project	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	0	Practicals	28	Project	0
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography										10

3.3.2. Research in library, study of electronic resources, field research	10
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (video projector, PC). Lecture notes. Recommendedbibliography.
5.2. for practicals/tutorials/projects	Lab room, experimental setups, powersupplies, measurementinstruments, oscilloscopes

6. Specific competences acquired

Professional competencies	C1. The identificationandtheappropriateuse of themain computer skills. C2. The use of suitable software packages for data analysisandprocessing. C3. Solvingphysicsproblemsundergivenconditionsusing PC for analytical, numerical, and statisticalmethods. C5. The abilitytoanalyzeandtocommunicatethe didactic, scientificand popularizationinformation of Physics.
Transversal competencies	CT3 - The efficientuse of theinformationsourcesandthecommunicationand professionaldevelopmentresources in Romanian Institute and a widelyusedforeignlanguage (English), as well.

7. Course objectives

7.1. General objective	• Knowledgeandunderstanding: knowledgeandappropriateuse of the specific notions of informatic system. • Achieving a thoroughtheoreticalknowledge. • Gainingcomputationskills.
7.2. Specific objectives	• Knowledgeandappropriateuse of the fundamental concepts of mathematicalandinformaticalanalysis. • Developingtheabilitytowork in a team. • Developingcomputationalskills. • The use of LabView software for dealingwithdifferent software solutions.

8. Contents

8.1. Lectures[chapters]	Teaching techniques	Observations
Experimental techniques in modern physics. Sensors and data acquisition	Systematicexposition - lecture. Examples.	2 hours
Software applications – LabVIEW programming package. Virtual instruments. G programming language: data types, structures, I/O operations.	Systematicexposition - lecture. Examples.	12 hours
VISA architecture. GPIB and RS485 buses.	Systematicexposition - lecture. Examples.	6 hours
Data acquisition and processing in physics experiments. Hardware configurations.	Systematicexposition - lecture. Examples.	8 hours
Bibliography: 1. G Programming Reference Manual, National Instruments. 2. L. Ion, Course notes (slides) 3. R.Baican, D.S. Necsulescu, Applied Virtual Instrumentation (WIT Press, Southampton, UK, 2000)		

8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		

8.3. Practicals	Teaching and learning 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
Bibliography:		

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 holders of the discipline consulted the content of similar disciplines taught at universities in the country and abroad. The content of the discipline is in line with the standards used in research and industry. This course unit develops some theoretical and practical competences and abilities, which are important for an undergraduate student in the field of modern Physics, corresponding to national and international standards. The contents and teaching methods were selected after a thorough analysis of the contents.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- ability to use specific programming and data processing techniques	Design and implementation of a virtual instrument	70%
10.5.1. Tutorial			
10.5.2. Practical	-ability to use specific programming techniques - ability to present and discuss the results	Development of specific modules	30%
10.5.3. Project			
10.6. 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.			

Date
8.11.2021

Teacher’s name and signature
Assoc Prof. Adrian RADU

Practicals/Tutorials instructor(s) name(s) and signature(s)
Assoc Prof. Adrian RADU

Date of approval
11.11.2021

Head of Department
Assoc Prof. Adrian RADU

DO.213F.2EN. Plasma physics and applications

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers

1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

<table>
<tr><td colspan="2">2.1. Course unit title</td><td colspan="8">Plasma Physics and Application</td></tr>
<tr><td colspan="5">2.2. Teacher</td><td colspan="5">Lect. Dr. Dragoş Iustin PALADE</td></tr>
<tr><td colspan="5">2.3. Tutorials/Practicals instructor(s)</td><td colspan="5">Lect. Dr. Dragoş Iustin PALADE</td></tr>
<tr><td rowspan="2">2.4. Year of study</td><td rowspan="2">2</td><td rowspan="2">2.5. Semester</td><td rowspan="2">2</td><td rowspan="2">2.6. Type of evaluation</td><td rowspan="2">E</td><td rowspan="2">2.7. Classification of course unit</td><td>Content [1)]</td><td>DS</td></tr>
<tr><td>Type [2)]</td><td>DO</td></tr>
</table>

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Project	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	0	Practicals	28	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	14
3.3.2. Research in library, study of electronic resources, field research	12
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	14
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Optics, Electricity and Magnetism, Molecular Physics, Atomic Physics
4.2. competencies	Computer programming

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia equipped class (video-projector) Recommended bibliography
5.2. for practicals/tutorials/projects	Experimental setup fro the Laboratory of Plasmas Physics. Recommended bibliography

6. Specific competences acquired

Professional competencies	- To develop the ability to properly use the notions of plasma physics; - To acquire skills and experimental techniques in the study of various types of plasmas. - To identify and choose the various types of plasmas suitable for their technological applications-Identification and appropriate use of main laws and principles of physics in a given context.
Transversal competencies	- Show concern for professional development by training critical thinking skills; - Show involvement in scientific activities, such as the development of specialized articles and studies; - The ability to work in teams;

7. Course objectives

7.1. General objective	Understanding the role of plasma phenomena in fundamental knowledge and applied science
7.2. Specific objectives	Objectiv 1: Fundamental knowledge. The students will be competent in the physical and mathematical fundamentals of plasma applications, enabling them to address the issues of plasma physics conceptual, analytical, numerical and experimental. Objectiv 2: Practical.

	Students will get skills on plasma techniques needed to overcome the technical challenges of the future. Objectiv 3: Design and development. Students will be able to project a new plasma discharge experimental set-up in a multidisciplinary team. Objectiv 4: Communication. Students will be able to communicate scientific and technical information orally or in written and graphic form Objectiv 5: Behavior. Students will act ethically and will assess the impact of plasma sciencies on society, economy and environment.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Introduction. The plasmas in space and in the Laboratory. What is plasma? Plasma vs ionized gases Debye length, plasma frequency, quasineutrality.	Systematic exposition - lecture. Heuristic conversation. Examples	4 h
The elementary processes and the plasma equilibrium.. Transport phenomena in plasma	Systematic exposition - lecture	4 h
Interaction between plasma and electromagnetic waves	Systematic exposition - Lecture	2 h
The physical models for plasmas. Fluid models. Kinetic description of plasmas	Systematic exposition - Lecture	4 h
Breakdown and ignition Electrical breakdown. Optical breakdown	Systematic exposition - Lecture	2 h
Plasma Sources Glow discharge plasma. RF plasma. Microwaves plasma. Fusion plasma. Other plasma sources.	Systematic exposition - Lecture	4 h
Plasma Diagnostics Electrical Methods. Optical Methods	Systematic exposition - Lecture	4 h
The plasma & technologies	Systematic exposition - Lecture	4 h

Bibliography:
Bibliografie:

I.I. Popescu, D. Ciobotaru.- Bazele fizicii plasmei, Editura Tehnică. Bucureşti 1987
I.I.Popescu, I.Iova E.I. Toader, - Fizica plasmei şi aplicaţii, Editura Ştiinţifică şi Enciclopedică.Bucureşti, 1981
I.Iova , I.I.Popescu, E.I. Toader, - Bazele spectroscopiei plasmei, Editura Stiintifica si Enciclopedica, Bucuresti, 1983
Gh. Popa,-Fizica plasmei, www.phys.uaic.ro
M. A. Lieberman, A. J. Lichetenberg - Principles of Plasma Discharges and Materials Processing, John Wiley, New York, 1994
B. Chapman, - Glow Discharges Processes – Sputtering and Plasma Etching. John Wiley & Sons, New York, 1980
Y.P.Raizer - Gas Discharge Physics, Springer-Verlag, Berlin, 1991
R.Dendy (editor) Plasma Physics: an Introductory Course,Cambridge University Press, 1999
R. Huddlestone, S. L. Leonard (editors) - Plasma Diagnostic . Techniques, Academic Press, New York, 1965
Lochte Holtgreven (editor) - Plasma Diagnostics, Amsterdam, North-Holland,1968

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
Vacuum Technology	Guided practical activity	2h
Electrical Breakdown. Pachen’s law	Guided practical activity	2h
Electrical Breakdown in magnetic fields	Guided practical activity	2h
Parametric analysis of plasma	Guided practical activity	2h
Arc Plasmas	Guided practical activity	2h
Glow Discharge Plasma;	Guided practical activity	2h

Electric RF discharge	Guided practical activity	2h
Plasma conductivity measurements	Guided practical activity	2h
Diagnostic of the electronic temperature and electronic density via simple electric methods: the Langmuir probe.	Guided practical activity	2h
Diagnostic of the electronic temperature and electronic density via electric methods: the Double Langmuir probe.	Guided practical activity	2h
Optical emission spectroscopy for electronic temperature plasma diagnostic	Guided practical activity	2h
Plasma jet at atmospheric pressure	Guided practical activity	2h
Reflex plasma reactor	Guided practical activity	2h
Testing the acquired knowledge on practicals	Conversation	2h

Bibliography:

V. Covlea, H. Andrei - Diagnosticarea plasmei - Lucrări de laborator, Editura Universitătii din Bucureşti, 2001

D. Ciobotaru, V. Covlea, C. Biloiu - Gaze ionizate - lucrări de laborator, Editura Universităţii din Bucureşti, Bucureşti, 1992 (in romanian)

C. Negrea,V. Manea,C. Vancea, A. Tudorica and V. Covlea – Ingineria plasmei, Editura Universitatii din Bucuresti, Bucuresti,2011

9. 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 competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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 (Cambridge University). The contents are in line with the requirements/expectations of the main employers of the graduates (industry, research, secondary school teaching - National Institute for Laser, Plasma and Radiation Physics, National Institute of Materials Physics, National Institute for Nuclear Physics, National Institute for Opto-Electronics).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyze specific examples	Final written evaluation: Final oral exam	60%
10.5.1. Tutorial			
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Written exam and group interview	40%
10.5.3. Project	- Clarity and coherence of the presentation; - Interpretation of results; - Correctness of answers;	Oral presentation	ADMITTED/ REJECTED

10.6. Minimal requirements for passing the exam

The ADMITTED grade for the project
A grade of 5 or higher in the practical evaluation
A grade of 5 or higher in the theoretical knowledge test.

Date	Teacher’s name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
25.10.2021	Lect. Dr. Dragoș Iustin Palade	Lect. Dr. Dragoș Iustin Palade

Date of approval
11.11.2021

Head of Department
Lector Dr. Roxana ZUS

DO.306F.1.EN Methods and techniques of presenting the results in physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Methods and techniques of presenting the results in physics							
2.2. Teacher				Lect.dr. Roxana ZUS				
2.3. Tutorials instructor								
2.4. Practicals instructor				Asist.drd. Andreea Mihaela CROITORU				
2.5. Year of study	3	2.6. Semester	V	2.7. Type of evaluation	C	2.8. Classification of course unit	Content 1)	DC
							Type 2)	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	2	distribution:	Lectures	1	Tutorials		Practicals	1	Project	
3.2. Total hours per semester	28	distribution:	Lectures	14	Tutorials		Practicals	14	Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	11
3.3.2. Research in library, study of electronic resources, field research	12
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	43
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Lecture hall with computer and video projector, computers network Lecture notes Bibliography
5.2. for practicals/tutorials/projects	Laboratory with computer and video projector, computers network Lecture notes Bibliography

6. Specific competences acquired

Professional competencies	▪ Using of software for data analysis and visualization ▪ Communication and analysis of didactic, scientific and popularization information in physics ▪ Interdisciplinary approach of some topics in physics
Transversal competencies	▪ Performing professional tasks efficiently and responsibly in compliance with the legislation and the deontology specific to the field under qualified assistance. ▪ Effective use of information sources, communication and training resources in a foreign language

7. Course objectives

7.1. General objective	Acquiring the techniques of redaction, processing and presentation of the results in physics
7.2. Specific objectives	▪ Understanding the specific problems and of structure of different types of scientific works and presentations ▪ Forming of DTP skills ▪ Forming of skills of processing and graphical presentation of scientific data ▪ Forming of skills of presenting results in a scientific work

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Structure of a scientific work; examples in physics **Scientific report** – characteristics and main elements Extended scientific works : – characteristics and main elements of a thesis Scientific paper characteristics and main elements	Case study. Guided work	3 hours
Examples of themes in physics for the project	Case study. Guided work	1 hour
Techniques of redaction presentation of the editing software for scientific works.		1 hour
Introduction in LaTeX Installing basic instructions math symbols, tables, graphics packages, classes, documents	Case study. Guided work	4 hours
Graphical representation, animations, videos; applications in physics	Case study. Guided work	3 hours
Structure of a scientific presentation installing and using beamertex designing a poster presentation	Case study. Guided work	2 hours
Bibliography: - Helmut Kopka, Patrick W. Daly, "A Guide to LATEX" (Fourth edition), Addison-Wesley, 2003 - Donald Knuth, „The TEXbook", Addison-Wesley, Reading MA, 1984 - Tobias Oetiker, Hubert Partl, Irene Hyna, Elisabeth Schlegl, „The Not So Short Introduction to LATEX 2ε'' - Harold Rabinowitz; Suzanne Vogel „The manual of scientific style : a guide for authors, editors, and researchers" Academic Press/Elsevier 2009 - Michael Alley The Craft of Scientific Presentations Springer2007 - John M. Swales, Christine B. Feak, Academic Writing for Graduate Students: Essential Tasks and Skills - A Course for Nonnative Speakers of English University of Michigan Press, 1994		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning	Observations

	techniques	
Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Introduction in LaTeX Installing basic instructions math symbols, tables, graphics packages, classes, documents	Case study. Guided work	5 hours
Structure of a scientific work; examples in physics Characteristics and main elements of a thesis **Scientific paper** - characteristics and main elements	Case study. Guided work	2 hours
Writing a scientific paper	Documentation. Case study. Guided work	3 hours
Designing of a scientific presentation Installing beamertex Design / structure of a scientific poster	Documentation. Case study. Guided work	2 hours
Analysis of the results	Documentation. Case study. Guided work	2 hours

Bibliography:

- Helmut Kopka, Patrick W. Daly, "A Guide to LATEX" (Fourth edition), Addison-Wesley, 2003
- Donald Knuth, „The TEXbook", Addison-Wesley, Reading MA, 1984
- Tobias Oetiker, Hubert Partl, Irene Hyna, Elisabeth Schlegl, „The Not So Short Introduction to LATEX 2ε''
- Harold Rabinowitz; Suzanne Vogel „The manual of scientific style : a guide for authors, editors, and researchers" Academic Press/Elsevier 2009
- Michael Alley „The Craft of Scientific Presentations" Springer, 2007
- John M. Swales, Christine B. Feak, Academic Writing for Graduate Students: Essential Tasks and Skills A Course for Nonnative Speakers of English University of Michigan Press, 1994
- Stefan Kottwitz, „Latex Beginner's Guide" (Second edition), Packt Publishing Ltd., 2021
- George Grätzer, „More math into Latex", (Fifth edition), Springer, 2016

Di Dilip Datta, „LATEX in 24 Hours - A Practical Guide for Scientific Writing", Springer, 2017

9. 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 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 University of Bucharest and of other national/international requirements for presentation of scientific works.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - ability to indicate/analyze specific examples	Written test/oral examination	40%
10.5.1. Tutorials			
10.5.2. Practicals			
10.5.3. Project [only if included in syllabus]	- coherence and clarity of exposition - correct use of techniques/ methods - ability to present and discuss the scientific paper and presentation	Report	60%
10.6. Minimal requirements for passing the exam			
Requirements for mark 5 (10 points scale) Frequency: 50% lecture attendance and attendance to 70% of applied activities (project). Correct presentation of 50% of theoretical subjects at the final examination. Passing the project presentation. 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 03.11.2021	Teacher's name and signature Lect.dr. Roxana Zus	Practicals/Tutorials instructor(s) name(s) and signature(s) Asist. drd. Andreea Croitoru

Date of approval 11.11.2021	Head of Department Lect.dr. Roxana Zus

DO.306F.2.EN History of physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	History of physics							
2.2. Teacher				Prof.univ.dr. Virgil BĂRAN				
2.3. Tutorials instructor								
2.4. Practicals instructor				Prof.univ.dr. Virgil BĂRAN				
2.5. Year of study	3	2.6. Semester	V	2.7. Type of evaluation	C	2.8. Classification of course unit	Content [1]	DC
							Type [2]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	2	distribution:	Lectures	1	Tutorials		Practicals	1	Project	
3.2. Total hours per semester	28	distribution:	Lectures	14	Tutorials		Practicals	14	Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	11
3.3.2. Research in library, study of electronic resources, field research	12
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	43
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Lecture hall with computer and video projector, computers network Lecture notes

	Bibliography
5.2. for practicals/tutorials/projects	Laboratory with computer and video projector, computers network Lecture notes Bibliography

6. Specific competences acquired

Professional competencies	▪ Using of software for data analysis and visualization ▪ Communication and analysis of didactic, scientific and popularization information in physics ▪ Interdisciplinary approach of some topics in physics
Transversal competencies	▪ Performing professional tasks efficiently and responsibly in compliance with the legislation and the deontology specific to the field under qualified assistance. ▪ Effective use of information sources, communication and training resources in a foreign language

7. Course objectives

7.1. General objective	Understanding the development of the main ideas in physics
7.2. Specific objectives	-Understanding the connection of physics with other sciences thorough the stages of development from antiquity toward modern physics -Forming of skills of processing and graphical presentation of scientific data related to the history of physics -Forming of skills of presenting results in a scientific work

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
1. Introductory lecture: why physics is a key science: the connection of physics with other sciences and branches of human knowledge.	Case study. Guided work	2 hours
2. The history of mechanics: the main stages from antiquity to present time**;** the transition from classical to relativistic mechanics of Einstein and Poincare **2Examples of themes in physics for the project**	Case study. Guided work	2 hours
3.The evolution of optics: the stages towards the present understanding of the light; from geometrical optics through undulatory optics and electromagnetism to photon . Applied optics and the evolution of human knowledge.	Case study. Guided work	2 hours
4. The history of electrodynamics: the main stages of evolution until the Maxwell theory. Light as an electromagnetic wave and the transition to Einstein relativity	Case study. Guided work	2 hours
5. The history of quantum mechanics: the experimental revolution at the beginning of twenty century; the stages towards the rigorous theory of the quantum phenomena. The interplay between quantum mechanics and relativity and the physical field concept, particles versus antiparticles.	Case study. Guided work	2 hours
6. The development of thermodynamics and statistical mechanics: thermal phenomena and crystallization of the principles of thermodynamics. From classical to quantum statistical mechanics; the phase transitions from Andrews experiments to renormalization group theory of K. Wilson. Statistical physics, information and life phenomena.	Case study. Guided work	2 hours
7. Physics in the XX-th century: the physics of the fundamental interactions and of the elementary particles,	Case study. Guided work	2 hours

condensed matter physics, nuclear physics, cosmology and astrophysics, the physics of earth, biophysics and medical physics.		
Bibliography: 1. The Cambridge Companion to Galileo Galilei, Isaac Newton, G. Leibniz, Cambridge University Press 2. P. Mittelstaedt, P. A. Weingartner, *Laws of Nature*, Springer Verlag, Berlin Heidelberg, 2005 3. E. Mach, *Mecanica. Expunere istorică şi critică a dezvoltării ei*, Editura All 4. C. Cercignani, *Ludwig Boltzmann*, Editura Tehnica 5. F. Wilczek, *The lightness of being: mass, ether and the unification of forces*, Perseus, 2008 6. M. von Laue, *History of Physics*, Pergamonn Press 7. J. Baggott, *The quantum story*, Oxford University Press, 2011 8.W. Applebaum, *The scientific revolution and the foundations of modern science*, Greenwood Press, 2005 9. T.S. Kuhn, *Structura Revolutiilor Stiintifice*, Editura Humanitas 10. M. Born, *Physics in my generation*, Springer-Verlag New York Inc. 11. K. Simony, *A cultural history of physics* 12. Virgil Baran – Istoria Fizicii-*Note de curs in format electronic (2019)*		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
1. Selecting the subjects fromhistory of physics for the scientific work General notion for scientic work writing. Scientific report – characteristics and main elements; extended scientific works : -characteristics and main elements of a thesis scientific paper- characteristics and main elements	Documentation. Case study. Guided work	1 hour
2. Development of mechanics: the contributions of Galileo Galilei, Isaac Newton, Henry Poincare, Albert Eistein	Documentation. Case study. Guided work	2 hours
3. Elaborating a scientific work in the history of physics: organization, the conclusions. Structure of a scientific work : examples from history of physics.	Documentation. Case study. Guided work	1 hour
4. Development of electrodynamics: the contribution of Benjamin Franklin, Charles-Augustin de Coulomb, Andre-Marie Ampere, Han Christian Oersted, Jean Baptiste Biot, Felix Savart, Michael Faraday, James Clerk Maxwell	Documentation. Case study. Guided work	2 hours
5. Development of optics: geometrical versus wave optics, phenomena and interpretation. Photoelectric effect and wave-corpuscle complementarity. The milestones towards the first important unification in physics.	Documentation. Case study. Guided work	2 hours
6.Development of thermodynamics and statistical mechanics:the contributions of L. Boltzmann, J.C. Maxwell, J. W. Gibbs, L. Landau, K. Wilson	Documentation. Case study. Guided work	2 hours
7. Development of quantum mechanics: contribution of M. Plank, N. Bohr, M. Born, W. Heisenberg, P.A. M. Dirac	Documentation. Case study. Guided work	2 hours
8. Elaboration of the scientific presentation for colloquium.	Documentation. Case study. Guided work	1 hour
9. Analysis of the results, discussion, interpretation of the results, perspectives.	Documentation. Case study. Guided work	1 hour
Bibliography: 1. The Cambridge Companion to Galileo Galilei, Isaac Newton, G. Leibniz, Cambridge University Press 2. P. Mittelstaedt, P. A. Weingartner, Laws of Nature, Springer Verlag, Berlin Heidelberg, 2005 3. E. Mach, Mecanica. Expunere istorică şi critică a dezvoltării ei, Editura All		

4. C. Cercignani, Ludwig Boltzmann, Editura Tehnica 5. F. Wilczek, The lightness of being: mass, ether and the unification of forces, Perseus, 2008 6. M. von Laue, History of Physics, Pergamonn Press 7. J. Baggott, The quantum story, Oxford University Press, 2011 8.W. Applebaum, The scientific revolution and the foundations of modern science, Greenwood Press, 2005 9. T.S. Kuhn, Structura Revolutiilor Stiintifice, Editura Humanitas 10. M. Born, Physics in my generation, Springer-Verlag New York Inc. 11. K. Simony, A cultural history of physics 12. Virgil Baran – Istoria Fizicii-Note de curs in format electronic (2019)

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 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 University of Bucharest and of other national/international requirements for presentation of scientific works.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - ability to indicate/analyze specific examples	Written test/oral examination	50%
10.5.1. Tutorials			
10.5.2. Practicals	- coherence and clarity of exposition - correct use of techniques/ methods - ability to present and discuss the scientific paper and presentation	Periodic evaluation/Report	50%
10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam			
Requirements for mark 5 (10 points scale) Frequency: 50% lecture attendance and attendance to 70% of applied activities (project). Correct presentation of 50% of theoretical subjects at the final examination. Passing the project presentation. Requirements for mark 10 (10 points scale) Correct presentation of the scientic work and of the project presentation at colloquium, appropriate interpretation of the results, correct answersto all questions.			

Date 03.11.2021	Teacher's name and signature Prof.dr. Virgil BĂRAN	Practicals/Tutorials instructor(s) name(s) and signature(s) Prof. dr. Virgil BĂRAN

Date of approval
11.11.2021

Head of Department
Lect.dr. Roxana Zus

DO.307F.1.EN Numerical methods in quantum mechanics

1. Study program

1.1. University	University of Bucharest

1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Numerical methods in quantum mechanics							
2.2. Teacher			Lect. Dr. Dragoş Iustin PALADE					
2.3. Tutorials/Practicals instructor(s)			Conf. Dr. Mădălina BOCA					
2.4. Year of study	3	2.5. Semester	6	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	5	distribution:	Lectures	2	Tutorials	1	Practicals	2	Project	0
3.2. Total hours per semester	50	distribution:	Lectures	20	Tutorials	10	Practicals	20	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	21
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	30
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	71
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Courses: Processing of physical data and numerical methods, Quantum mechanics, Algebra
4.2. competencies	Computer programming

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia equipped class (video-projector, whiteboard) Recommended bibliography
5.2. for practicals/tutorials/projects	Computer laboratory

6. Specific competences acquired

Professional competencies	Identify and properly use the main laws and physical principles in a given context Communication and analysis of information of a didactic, scientific and popularization nature in the field of Physics
Transversal competencies	Efficient use of information sources and resources of communication and assisted professional training, both in Romanian and in a language of international circulation.

7. Course objectives

7.1. General objective	Numerical solutions to a number of problems arising in quantum mechanics
7.2. Specific objectives	Developing the ability to write programs to find numerical solutions to quantum mechanics problems

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Microparticle in the 1D infinite potential well: solutions to the Schrodinger equation	Systematic exposition - lecture. Heuristic	2 h

	conversation, proof, case study. Examples	
Linear harmonic oscillator: eigenfunction of the energy operator and their Fourier transform. Non-stationary states: graphical representation of localization density probability.Wavepackage evolution for a free particle	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
Hydrogen atom: radial eigenfunctions of the energy operator. The analysis of the l=n-1 case; the radial function and the calculus of probability density maxima.	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
3D isotropic harmonic oscillator using spherical coordinates. Infinite spherical potential well	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
Numerov's method	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
Anarmonic linear oscilator. Posch-Teller potential	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
Kronig – Penney's model	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
The variational method	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
Using the variational method for the solutions of the He atom	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h
1D finite potential well: solving Schroedinger's equation.	Systematic exposition - lecture. Heuristic conversation, proof, case study. Examples	2 h

Bibliography:

1. P. Wellin, „Programming with Mathematica", Cambridge University Press, 2013
2. Robert L. Zimmerman, Fredrick I. Olness, "Mathematica For Physics: 2nd Edition", Addison-Wesley Publishing Company, 2002
3. Gerd Baumann, "Mathematica in Theoretical Physics", Springer-Verlag New York, 1996
4. Mathematica: S.Wolfram, "Mathematica: a system for doing mathematics by computer", Addison-Wesley, Redwood City, Calif., 1991
5. A. Messiah, ,,Mecanică cuantică", vol. I şi II (editiile in limba romana sau limba engleza)
6. K. Konishi, G. Paffuti, "Quantum mechanics. A new introduction", Oxford University Press, 2009

8.2. Tutorials	Teaching and learning techniques	Observations
Proof of the Baker - Cambell - Hausdorf identity and other relationships involving operators	Systematic exposition, examples, exercises, problems	2h
Applications of canonical transformations	Systematic exposition, examples, exercises, problems	4h
Applications of the variational method	Systematic exposition, examples, exercises, problems	2h
Hydrogen atom in the presence of a static and homogeneous electric field: finding the energy of the ground state using the variational method	Systematic exposition, examples, exercises, problems	2h

Bibliography:

1. A. Messiah, ,,Mecanică cuantică", vol. I şi II (editiile in limba romana sau limba engleza)
2. K. Konishi, G. Paffuti, "Quantum mechanics. A new introduction", Oxford University Press, 2009

8.3. Practicals	Teaching and learning techniques	Observations
Developing Mathematica codes for the topics discussed in the course and in the tutorials	Guided practical activity	20h

Bibliography: 1. P. Wellin, „Programming with Mathematica”, Cambridge University Press, 2013 2. Robert L. Zimmerman, Fredrick I. Olness, “Mathematica For Physics: 2nd Edition”, Addison-Wesley Publishing Company, 2002 3. Gerd Baumann, “Mathematica in Theoretical Physics”, Springer-Verlag New York, 1996 4. K. Konishi, G. Paffuti, ”Quantum mechanics. A new introduction”, Oxford University Press, 2009

9. 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 holders of the discipline consulted the content of similar disciplines taught at universities in the country and abroad. The content of the discipline is in accordance with the requirements for employment in research institutes in physics and technology and in education (in accordance with the law).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Appropriate acquisition and correct understanding of the topics covered in the course	Final written exam	60%
10.5.1. Tutorial	- Ability to solve problems of advanced quantum mechanics	Homeworks	10 %
10.5.2. Practical	- Ability to write codes in Mathematica to solve a quantum mechanics problem	Colloquy	30 %
10.6. Minimal requirements for passing the exam Attendance: attendance at a minimum of 50% of the number of course hours, attendance at a minimum of 75% of the number of seminar hours and 100% at the laboratory activity. Minimum 50% for each of the criteria that determine the final grade.			

Date	Teacher’s name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
10.11.2021	Lect. Dr. Dragoș Iustin Palade	Conf. Dr. Mădălina BOCA

Date of approval	Head of Department
11.11.2021	Lector Dr. Roxana ZUS

DO.307F.2.EN Elements of quantum optics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Theoretical Physics, Mathematics, Optics, Plasma, Lasers
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Elements of quantum optics							
2.2. Teacher				Associate prof. dr. Iulia Ghiu				
2.3. Tutorials/Practicals instructor(s)				Associate prof. dr. Iulia Ghiu				
2.4. Year of study	3	2.5. Semester	6	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	5	distribution:	Lectures	2	Tutorials	1	Practicals	2	Proj.	
3.2. Total hours per semester	50	distribution:	Lectures	20	Tutorials	10	Practicals	20	Proj.	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	24
3.3.2. Research in library, study of electronic resources, field research	22
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	25
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	75
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Quantum Mechanics, Optics, Algebra
4.2. competencies	A good level of algebra, geometry, trigonometry, real and complex analysis

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (video projector, PC).
5.2. for practicals/tutorials/projects	Laboratory

6. Specific competences acquired

Professional competencies	Using the law of physics in a proper way for a given problem. To be able to communicate and analyze the information from the lectures, from the scientific literature, as well as the information for popularization of physics.
Transversal competencies	Using in an efficient way the informational and communication resources in a foreign language.

7. Course objectives

7.1. General objective	Understanding the concepts of quantum optics, developing the ability of solving problems of quantum optics.
7.2. Specific objectives	Developing the ability of applying the principle of quantum mechanics and the formalism of quantum optics in order to understand complex problems of quantum optics.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Quantisation of the electromagnetic field	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
Quasidistribution in phase-space: Glauber-Sudarshan representation, Husimi function and Wigner function	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	4 h
Mono-mode squeezed states: definitions, properties, phase-space representation. Photon bunching and antibunching. Two-mode squeezed states	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	4 h
Mono-mode thermal state: the quasidistribution functions	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
The quantum description of the beam splitter. Applications	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h
Quantum communication with photons: quantum teleportation, quantum cryptography	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	4 h
Interference fenomena in one or two photodetectors. The Hong, Ou, Mandel experiment. Franson's experiment	Systematic exposition – lecture. Heuristic conversation. Critical analysis. Examples	2 h

Bibliography: 1. C. Gerry, P. Knight, Introductory Quantum Optics, Cambridge University Press, 2005. 2. M. O. Scully, M. S. Zubairy, Quantum Optics, Cambridge University Press, 2002. 3. Cohen-Tannoudji, Dupont-Roc, and Grynberg, Atom-Photon Interactions, Wiley, 1998. 4. D. F. Walls, G. J. Milburn, Quantum Optics, Springer Verlag, 1994. 5. C. W. Gardiner, Quantum Noise, Springer Verlag, 1991. 6. M. D. Al-Amri, M. M. El-Gomati, M. S. Zubairy (Editors), Optics in Our Time, Springer Open, 2016.		
8.2. Tutorials	Teaching and learning techniques	Observations
Mixed states of a two-level system. Bloch sphere	Problem solving. Guided work	2 h
Coherent states: definitions, properties, phase-space representation	Problem solving. Guided work	2 h
Inseparability in quantum mechanics. Condition for a two-photon state to be entangled	Problem solving. Guided work	2 h
Bell inequalities in quantum optics	Problem solving. Guided work	2 h
Optical implementations of quantum gates. The quantum eraser	Problem solving. Guided work	2 h
Bibliography: 1. C. Gerry, P. Knight, Introductory Quantum Optics, Cambridge University Press, 2005. 2. M. O. Scully, M. S. Zubairy, Quantum Optics, Cambridge University Press, 2002. 3. D. F. Walls, G. J. Milburn, Quantum Optics, Springer Verlag, 1994.		
8.3. Practicals	Teaching and learning techniques	Observations
Generation of photon pair entanglement	Guided practical activity	4 h
Single photon Michelson interferometer	Guided practical activity	4 h
Quantum key distribution used in quantum cryptography	Guided practical activity	4 h
Houng-Ou-Mandel experiment	Guided practical activity	4 h
Numerical simulations for the study of the Glauber-Sudarshan representation, Husimi function and Wigner function for different states	Guided practical activity	2 h
Numerical simulations for the study of inseparability in quantum mechanics for some specific states	Guided practical activity	2 h
Bibliography: 1. C. Gerry, P. Knight, Introductory Quantum Optics, Cambridge University Press, 2005. 2. M. O. Scully, M. S. Zubairy, Quantum Optics, Cambridge University Press, 2002. 3. D. F. Walls, G. J. Milburn, Quantum Optics, Springer Verlag, 1994. 4. quED - Entanglement Demonstrator - A Science Kit for Quantum Physics, www.qutools.com.		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Understanding the basic concepts of Quantum optics - Correct use of equations and physical models	Written examination	60 %
10.5.1. Tutorial	- Ability of solving problems of Quantum optics	Homeworks	10 %
10.5.2. Practical	- Ability to give the interpretation for the experimental results	Evaluation through practical activity	30 %

10.5.3. Project			
10.6. Minimal requirements for passing the exam For getting the mark 5: Attending minimum 50 % of the lectures, 75 % of the tutorials and 100% for the lab activities. Minimum 50 % of the requirements for the final mark.			

Date	Teacher's name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
5.11.2021	Associate prof. dr. Iulia Ghiu	Associate prof. dr. Iulia Ghiu

Date of approval	Head of Department
11.11.2021	Lect. dr. Roxana Zus

DO.308.F.1.EN Detectors Dosimetry and Radiation Protection

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of MatterStructure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Detectors Dosimetry and Radiation Protection**							
2.2. Teacher				Prof. dr. Ionel Lazanu, Conf. dr. Oana Ristea				
2.3. Tutorials/Practicals instructor(s)				Asist. Drd. Mihaela Parvu				
2.4. Year of study	3	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1]	DS
							Type [2]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Project	0
3.2. Total hours per semester	40	distribution:	Lectures	20	Tutorials	0	Practicals	20	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	40
3.3.2. Research in library, study of electronic resources, field research	25
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	16
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	81
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Pre-requirements: The equations of mathematical physics, Physics of the atom and molecule, Nuclear and particle physics, Electronics
4.2. competencies	Knowledge of Mathematics, Atomic and Nuclear Physics, Quantum mechanics, Programming languages and numerical methods etc.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphytheatre equipped with multimedia devices (video)
5.2. for practicals/tutorials/projects	Radioactive isotopic sources, experimental set up for nuclear spectroscopy, radiation detectors (gas, scintillators, semiconductors), multichannel analyzers, radiation monitors

6. Specific competences acquired

Professional competencies	C1: The identification and appropriate use of main physical laws and principles in a given context. C1.1: The deduction of working formulae for calculations of physical quantities using appropriate principles and laws of physics. C1.2: The description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) C1.3: Applying the principles and laws of physics in solving theoretical or practical problems with qualified assistance. C1.4: The correct application of methods of analysis and criteria for the selection of appropriate solutions to achieve specified performance. C3: Troubleshooting the physical conditions required using numerical and statistical methods C3.1: Using adequate data analysis and processing of numerical methods specific physics and mathematical statistics C3.3: Linking methods of statistical analysis problems to date (to obtain measurements / calculations, data processing, interpretation). C 3.4: Evaluating the reliability of results and comparing them to bibliographic data or theoretical calculated values using statistical methods for validation and / or numerical methods C4: Applying knowledge in physics both in concrete situations from related fields, and in some experiments using standard laboratory equipment. C6: Addressing interdisciplinary themes from physics C6.1: Making connections necessary to use physical phenomena using basic knowledge of related fields (chemistry, biology, etc.) C6.4: Making connections between knowledge of physics and other fields (Chemistry, Biology, Computer Science, etc.).
Transversal competencies	CT2: Applying the techniques of effective multidisciplinary team working on various hierarchical levels. CT3: Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	Presentation of fundamental concepts related to radiation interactions with matter, including living matter, radiation sources, mechanisms of interaction used for their detection, classes of detectors, properties, the principles of dosimetry, specific calculations
7.2. Specific objectives	Understanding of the specific aspects of physical phenomena, at the atomic and nuclear level; the ability to operate with these concepts and phenomena. Development of experimental skills specific to this domain. Understanding of the main classes of applications in everyday life.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Fundamental processes of the interaction of radiation with substance: (a) energy losses by ionization and excitation of the heavy charged particles, ions and electrons; (b) interactions of photons; (c) neutrons; (d) muons	Systematic exposition - lecture. Examples	5 hours
2. Radiation Sources: Isotopic sources, particle accelerators, nuclear reactors, cosmic rays	Systematic exposition - lecture. Examples	2 hours
3. General properties of detectors. The main physical phenomena used to detect particles. Different types of detectors. Operating Principles	Systematic exposition - lecture. Examples	8 hours

4. Dosimetry. Basic quantities and units. Dosimetric calculation depending on the type of radiation source (external / internal) and on the spatial dimension of the source.	Systematic exposition - lecture. Examples	2 hours
5. Dosimetric measurement. Dosimetry methods. Radioprotection. Dosimetry and radiation protection standards.	Systematic exposition - lecture. Examples	2 hours
6. Elements of medical dosimetry. Dosimetry at particle accelerators and at high power lasers		1 hour
Bibliography: 1. F. Attix, Introduction to radiological physics and radiation dosimetry, John Whiley &Sons, 1986 2. Brian R Martin, Nuclear and Particle Physics – An Introduction, 2nd_Edition, 2009 3. WR Leo, Techniques for nuclear and particle physics experiments, 2nd Edition Springer-Verlag , 1994 4. Manuale scrise de membrii Catedrei de Fizica atomica si nucleara, autori diferiti, diferite editii 5. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994 6. G.F. Knoll, Radiation Detection and Measurement, Wiley, 2000 7. C. Grupen, B. A. Swartz, Particle Detectors, Cambridge University Press 2008		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
1. Energy calibration of detection systems. Spectrum processing and extraction of relevant information 2. Study of the sensitivity of scintillation detectors 3. Determination of the dead time for scintillation detectors 4. Information processing at visualization detectors 5. Study of the detection efficacity of different types of detectors 6. MC simulations (TRIM, GEANT4) of heavy ion interactions in matter and biological tissue	Guided practical activities	2 hours 2 hours 2 hours 2 hours 2 hours 4 hours
Dosimetric calculation and radiation protection problems	Guided work	4 hours
Examination		2 hours
Bibliography: 1. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994 2. Lucrari practice de Fizica nucleara, Îndrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 1987 3. Bazele Fizicii nucleare, Lucrari practice, Indrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară (editor Mihaela Sin), Ed. Univ. Bucureşti, 2003 4. 1000 solved problems in Modern Physics, A. Kamal, Springer-Verlag, 2010 5. Problems and solutions on Atomic, Nuclear and Particle Physics, Y.-K. Lim, World Scientific, 2000 6. https://geant4.web.cern.ch/ 7. http://www.srim.org/		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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/or practical competences and abilities which are important and fundamental for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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 from the EU (University of Oxford https://www.ox.ac.uk/admissions/undergraduate/courses-listing?wssl=1, University of Parma http://www.difest.unipr.it/it/didattica/laurea-triennale-fisica/calendario-didattico, Universitatea Padova, http://en.didattica.unipd.it/didattica/2015/SC1158/2014). The contents are in line with the requirements of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Oral examination	60%
10.5.1. Tutorial			
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present, analyze and discuss the results - ability to use specific problem solving methods	Lab reports	40%
10.5.3. Project			
10.6. Minimal requirements for passing the exam Correct understanding of the concepts and phenomena, the ability to work with them and obtain accurate numerical results on topics imposed. Requirements for mark 5 (10 points scale) All practical works finished and 5 score at the examination of the laboratory activity. The correct exposure of the subjects indicated to derive the score 5 at the final exam.			

Date 03.11.2021	Teacher’s name and signature Prof. dr. Ionel Lazanu Conf. dr. Oana Ristea	Practicals/Tutorials instructor(s) Asist. Drd. Mihaela Parvu

Date of approval 11.11.2021	Head of Department Prof. Dr. Alexandru Jipa

DO.308.F.2.EN Radiation sources. Natural and induced radioactivity

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of MatterStructure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)

1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Radiation sources. Natural and induced radioactivity**								
2.2. Teacher				Prof. dr Ionel Lazanu, Conf. dr. Oana Ristea					
2.3. Tutorials/Practicals instructor(s)				Asist. Drd. Mihaela Parvu					
2.4. Year of study	3	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DS	
							Type 2)	DO	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Project	0
3.2. Total hours per semester	40	distribution:	Lectures	20	Tutorials	0	Practicals	20	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	40
3.3.2. Research in library, study of electronic resources, field research	25
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	16
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	81
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Pre-requirements: The equations of mathematical physics, Physics of the atom and molecule, Nuclear and particle physics, Electronics
4.2. competencies	Knowledge of Mathematics, Atomic and Nuclear Physics, Quantum mechanics, Programming languages and numerical methods etc.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphytheatre equipped with multimedia devices (video)
5.2. for practicals/tutorials/projects	Radioactive isotopic sources, experimental set up for nuclear spectroscopy, radiation detectors (gas scintillators, semiconductors), multichannel analyzers, radiation monitors

6. Specific competences acquired

Professional competencies	C1: The identification and appropriate use of main physical laws and principles in a given context. C1.1: The deduction of working formulae for calculations of physical quantities using appropriate principles and laws of physics. C1.2: The description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) C1.3: Applying the principles and laws of physics in solving theoretical or practical problems with qualified assistance. C1.4: The correct application of methods of analysis and criteria for the selection of appropriate solutions to achieve specified performance. C3: Troubleshooting the physical conditions required using numerical and statistical methods C3.1: Using adequate data analysis and processing of numerical methods specific physics and mathematical statistics C3.3: Linking methods of statistical analysis problems to date (to obtain measurements / calculations, data processing, interpretation). C 3.4: Evaluating the reliability of results and comparing them to bibliographic data or theoretical calculated values using statistical methods for validation and / or numerical methods C4: Applying knowledge in physics both in concrete situations from related fields, and in some experiments using standard laboratory equipment.

	C6: Addressing interdisciplinary themes from physics C6.1: Making connections necessary to use physical phenomena using basic knowledge of related fields (chemistry, biology, etc.) C6.4: Making connections between knowledge of physics and other fields (Chemistry, Biology, Computer Science, etc.).
Transversal competencies	CT2: Applying the techniques of effective multidisciplinary team working on various hierarchical levels. CT3: Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	Presentation of fundamental concepts related to radiation interactions with matter, including living matter, radiation sources, mechanisms of interaction used for their detection, classes of detectors, properties, the principles of dosimetry, specific calculations
7.2. Specific objectives	Understanding of the specific aspects of physical phenomena, at the atomic and nuclear level; the ability to operate with these concepts and phenomena. Development of experimental skills specific to this domain. Understanding of the main classes of applications in everyday life.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Fundamental processes of interaction of the radiation with matter. Effects of radiation on the population and environment.	Systematic exposition - lecture. Examples	5 hours
2. Radiation sources. Cosmic radiation. Primary and secondary sources. Cosmogenic radionuclides. Radioactive series. Their distributions in nature. Analysis of the Ra-226 and K-40 . Air radioactivity (Rn-222, R-220 and their descendants). Distribution of radon in the atmosphere and housing.	Systematic exposition - lecture. Examples	5 hours
3. Artificial radioactivity. Particle accelerators, nuclear reactors, neutron sources (spallation), medical and industrial sources, high power lasers, nuclear weapons.	Systematic exposition - lecture. Examples	4 hours
4. The nuclear reactor as a source of radioactivity.	Systematic exposition - lecture. Examples	2 hours
5. Elements of the dosimetry. Basic quantities and units. Dosimetric measurement. Dosimetry methods. The principles of radiation protection. Dosimetry and radiation protection standards.	Systematic exposition - lecture. Examples	4 hours

Bibliography:
1. F. Attix, Introduction to radiological physics and radiation dosimetry, John Whiley &Sons, 1986
2. Brian R Martin, Nuclear and Particle Physics – An Introduction, 2nd_Edition, 2009
3. WR Leo, Techniques for nuclear and particle physics experiments, 2nd Edition Springer-Verlag , 1994
4. M. L. Anunziata, Handbook of radioactivity analysis, Academic Press 2012
5. O. Sima, Note de curs Radioactivitatea mediului
6. G.F. Knoll, Radiation Detection and Measurement, Wiley, 2000

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations

1. Gamma spectrometry using scintillation and semiconductor detectors 2. Calibration of germanium spectrometer for environmental samples measurements (matrix effects and coincidence effects are considered) 3. Alpha and beta spectrometry on thick samples 4. Radon flux measurements of ambient concentration and dose calculations 5. Thermoluminescence dosimetry 6.Calibration of a dosimetry system	Guided practical activities	2 hours 2 hours 2 hours 4 hours 2 hours 2 hours
Numerical applications in dosimetry and radioprotection	Guided work	4 hours
Examination		2 hours

Bibliography:

1. Fizica nucleara – Culegere de probleme (Catedra de fizica atomica si nucleara), Editura All, 1994
2. Lucrari practice de Fizica nucleara, Îndrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 1987
3. Bazele Fizicii nucleare, Lucrari practice, Indrumător de laborator, Colectivul Catedrei de Fizică atomică şi nucleară, Ed. Univ. Bucureşti, 2003
4. 1000 solved problems in Modern Physics, A. Kamal, Springer-Verlag, 2010
5. Problems and solutions on Atomic, Nuclear and Particle Physics, Y.-K. Lim, World Scientific, 2000

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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/or practical competences and abilities which are important and fundamental for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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 from the EU (University of Oxford https://www.ox.ac.uk/admissions/undergraduate/courses-listing?wssl=1, University of Parma http://www.difest.unipr.it/it/didattica/laurea-triennale-fisica/calendario-didattico, Universitatea Padova, http://en.didattica.unipd.it/didattica/2015/SC1158/2014).
The contents are in line with the requirements of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Oral examination	60%
10.5.1. Tutorial			
10.5.2. Practical	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments	Lab reports	40%

	- ability to present, analyze and discuss the results - ability to use specific problem solving methods		
10.5.3. Project			

10.6. Minimal requirements for passing the exam Correct understanding of the concepts and phenomena, the ability to work with them and obtain accurate numerical results on topics imposed. Requirements for mark 5 (10 points scale) All practical works finished and 5 score at the examination of the laboratory activity. The correct exposure of the subjects indicated to derive the score 5 at the final exam.

Date
27.10.2021

Teacher's name and signature
Prof. dr. Ionel Lazanu
Conf. dr. Oana Ristea

Practicals/Tutorials instructor(s)
Asist. Drd. Mihaela Parvu

Date of approval
11.11.2021

Head of Department
Prof. Dr. Alexandru Jipa

DO.309F.1.EN Introduction to Polymers Physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	o Introduction to Polymer Physics							
2.2. Teacher				Conf.Dr.Anca Dumitru				
2.3. Tutorials/Practicals instructor(s)				Conf.Dr.Anca Dumitru				
2.4. Year of study	3	2.5. Semester	6	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1]	DS
							Type[2]	DO

[1] fundamental (DF), speciality (DS), complementary (DC); [2] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials		Practicals	2	Project	
3.2. Total hours per semester	40	distribution:	Lectures	20	Tutorials		Practicals	20	Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	35
3.3.2. Research in library, study of electronic resources, field research	22
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	24
3.3.4. Examination	4
3.3.5. Other activities	X

3.4. Total hours of individual study	81
3.5. Total hours per	125

semester	
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	The equations of mathematical physics, thermodinamics and molecular physics, chemistry, Electricity
4.2. competences	Knowledge of General Physics, Chemistry and Mathematics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphitheater equipped with multimedia devices
5.2. for practicals/tutorials	Set of practical work illustrating the topics covered in the course; Consumables; Computers and software for data analysis

6. Specific competences acquired

Professional competences	**C1**: Identification and appropriate use of main physical laws and principles in a given context. **C1.1**: Deduction of working formulas for calculations of physical quantities using appropriate principles and laws of physics. **C1.2**: description of physical systems, using theories and specific tools (theoretical and experimental models, algorithms, schemes, etc.) **C1.3**: Applying the principles and laws of physics in problem solving theoretical or practical, in terms of qualified assistance. **C1.4**: Correct application of methods of analysis and criteria for the selection of appropriate solutions to achieve specified performance **C4.** Applying knowledge of physics in both, concrete situations from related fields and in some experiments using standard laboratory equipment. **C6:** Addressing interdisciplinary themes from physics area **C6.1:** Making connections necessary to use physical phenomena using basic knowledge of related fields (chemistry, biology, etc.) **C6.4**: Making connections between knowledge of physics and other fields (Chemistry, Biology, Computer Science, etc.).
Transversal competences	**CT2**: Applying the techniques of effective multidisciplinary team working on various hierarchical levels. **CT3**: Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.

7. Course objectives

7.1. General objective	This course gives an overview of the fundamental aspects of polymers from the synthesis of polymers to characterization, properties, and applications of polymers for undergraduate students.
7.2. Specific objectives	Develop fundamental understanding of polymers, polymeric reactions and properties; recognize the potential value of polymeric materials and their areas of application; ability to interpret and analyze experimental data; become familiar with current topics in polymer science; ability to use analysis techniques to identify the properties of polymer materials of interest in modern applications; work in a team for solving experimental and technological issues; identify and use bibliographic resources for continuous formation; Understanding main

	classes of applications in everyday life.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
History, Definition and Concept of Polymers. Introduction to the history of polymer science. Definition of the concept of polymer, by describing the types of polymers based on chemical structure and origins.	Systematic exposition - lecture. Conversation. Examples	2 hours
Classification of polymers. Classification of polymers based on: origin, chemical composition of monomer, chemical composition of polymers, nature of polymer chain, degree of polymerization, type of polymerization reactions, polymer configuration, thermo- mechanical behavior, microscopic arrangement of molecules and applications	Systematic exposition - lecture. Conversation. Examples	2 hours
Molecular weight of polymers. Description of the concepts of average molecular weights of polymer and of molecular weight distribution and principles and methods for measuring them.	Systematic exposition - lecture. Conversation. Examples	2 hours
Polymerization,Reactions and Polymerization Processes. Description of polymerization reactions: addition polymerization and step growth polymerization; Description of polymerization processes: bulk polymerization, suspention polymerization, emulsion polymerization and special processes.	Systematic exposition - lecture. Conversation. Examples	4 hours
Electrical properties of polymers. Dielectrics properties of polymers. Relaxation and dielectric losses in polymers. Applications of dielectric polymers. Semiconducting properties of polymers**.** Description of synthesis methods and applications of semiconducting polymers.	Systematic exposition - lecture. Conversation. Examples	4 hours
Methods of characterization. Brief presentation of characterization methods particulary used for polymers materials including Infrared and Raman Spectroscopy, X-ray photoelectron Sepctroscopy, X-ray Diffraction and Thermal Analysis.	Systematic exposition - lecture. Conversation. Examples	6 hours

Bibliography:

- Nicholson J.W., The Chemistry of Polymer, RSC Publishing, Cambridge, UK, 2012.
- L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley and Sons (2005)
- David I. Bower, An introduction to Polymer Physics, Cambridge University Press (June 5, 2012), ISBN: 9780521637213;
- Handbook of conducting polymers, vol. I. New York: Marcel Dekker; 1986. p. 265–91.
- L.Constantinescu, C.Berlic, “Metode experimentale in fizica polimerilor” Ed. Univ. Din Bucuresti, 1999
- L.Constantinescu, C.Berlic, “Structura polimerilor. Metode de studiu” Ed. Univ. Din Bucuresti, 2003
- R J Young and P A Lovell, Introduction to Polymers, Chapman & Hall, 1992.
- R Moore, D E Kline, Properties and Processing of Polymers for Engineers, Prentice-Hall, 1984
- D H Morton-Jones, Polymer Processing, Chapman & Hall, 1989.
- C.D. Wagner, W.M. Riggs, L.E. Davis, J.F. Moulter, G.E. Muilenberg, *Handbook of X-ray Photoelectron Spectroscopy*, Perkin-Elmer Corporation (1978).
- http://www.pslc.ws/mactest/maindir.htm
- “X-ray Diffraction Procedures for Polycrystalline and Amorphous Materials”, Harold P. Klug and L. R. Alexander, Wiley-Interscience, 1974

8.2. Tutorials [main themes]	Teaching and learning techniques	Observations

Bibliography:
...whatever you decide to indicate...

8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations

1. Oxidative polymerization of aniline 2. Oxidative polymerization of pyrrole 3. Electrochemical synthesis of polyaniline/polypyrrole 4. Analysis and interpretation of FTIR spectra of polyaniline/polypyrrole 5. Analysis and interpretation of RAMAN spectra of polyaniline/polypyrrole 6. Determination of the degree of crystallinity of a polymer using X-ray diffraction (XRD). Analysis and interpretation of the data. 7. Analysis of XPS spectra of polymer materials.	Guided practical activity	18 hours
Laboratory examination		2h

Bibliography:
1.Handbook of conducting polymers, vol. I. New York: Marcel Dekker; 1986. p. 265–91.
2.L.Constantinescu, C.Berlic, "Metode experimentale in fizica polimerilor" Ed. Univ. Din Bucuresti, 1999
3.C.D. Wagner, W.M. Riggs, L.E. Davis, J.F. Moulter, G.E. Muilenberg, Handbook of X-ray Photoelectron Spectroscopy, Perkin-Elmer Corporation (1978).
4. "X-ray Diffraction Procedures for Polycrystalline and Amorphous Materials", Harold P. Klug and L. R. Alexander, Wiley-Interscience, 1974
5.Fred A. Stevie, and Carrie L. Donley, Introduction to x-ray photoelectron spectroscopy, J. Vac. Sci. Technol. A 38(6) Nov/Dec 2020
6.Elvira De Giglio, Nicoletta Ditaranto, and Luigia Sabbatini , Cpap.3 -Polymer surface chemistry: Characterization by XPS, in the book Polymer Surface Characterization, Ed. Berlin/Boston De Gruyter, 2014 (e-book)

8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations

Bibliography:
...whatever you decide to indicate...

9. 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 forms/develops some theoretical and/or practical competences and abilities which are important/fundamental/something else for an undergraduate student in the field of modern Physics, corresponding to national and european/international standards. 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 and around the world (University of Pittsburgh, Massachusetts Institute of Technology; Virginia Tech University, Upsala University). The contents are in line with the requirements/expectations of the main employers of the graduates (industry, research, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of knowledge and theminology used in polymer physics - ability to indicate/analyse specific examples	Presentation/Oral examination	70%
10.5.1. Tutorials			
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to analyse and interpret the characterization data - ability to present and discuss the results	Examination of Lab reports	30%
10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam Fulfilments of at least 50% of each of the criteria that determine the final grade.			
Requirements for mark 5 (10 points scale)			

Completion of 80% of laboratory and mark 5 to the colloquium Good understanding and exposure of a selected subject

Date	Teacher's name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
18.10.2021	Conf. dr. Anca Dumitru	Conf. dr. Anca Dumitru

Date of approval	Head of Department
11.11.2021	Prof. dr. Alexandru Jipa

DO.309F.2.EN Introduction to environmental physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Introduction to environmental physics								
2.2. Teacher				Prof. dr. Mihai Dima					
2.3. Tutorials/Practicals instructor(s)				Prof. dr. Mihai Dima					
2.4. Year of study	3	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1]	DF	
							Type[2]	DS	

[1] fundamental (DF), speciality (DS), complementary (DC); [2] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials		Practicals	2	Project	
3.2. Total hours per semester	40	distribution:	Lectures	20	Tutorials		Practicals	20	Project	
3.3 Distribution of estimated time for study										hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography										35
3.3.2. Research in library, study of electronic resources, field research										22
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks										24
3.3.4. Examination										4
3.3.5. Other activities										0

3.4. Total hours of individual study	81
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	...some (preceding) courses
4.2. competences	...some previously formed competences / Not applicable

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Amphitheater equipped with multimedia devices
5.2. for practicals/tutorials	Set of practical work illustrating the topics covered in the course; Consumables;

	Computers and software for data analysis

6. Specific competences acquired

Professional competences	C1 – Understanding of the current most important global environmental problems C2 – Solving imposed condition environmental physics problems C3 - Apply knowledge of environmental physics in experiments using standard laboratory equipment C4 – Communication and analysis of didactic, scientific and dissemination of information
Transversal competences	CT1- Achievement of the professional duties in an efficient and responsible way with compliance with deontological legislation specific to the domain under qualified assistance. CT3 - Effective use of information, communication and training assistance in English.

7. Course objectives

7.1. General objective	The assimilation of general framework of macroscopic and microscopic studies of thermal phenomena
7.2. Specific objectives	Knowledge and understanding - Understanding the main current global environmental problems - Assimilation of the main components of the general circulation of atmosphere and ocean - Assimilation of the main critical components of the climate system - The knowledge of description of thermodynamic system by state equations and the connections with response functions. - Understanding the multiple dimensions of climate change and its physical and socio-economic implications Explanation and interpretation Connection between the theoretical concepts defined in lecture and experimental investigation in practical work in the laboratory. The practical application of the general principles in solving the concrete problems.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
Actual environmental problems: global warming and climate change, distruction of the Ozone layer, pollution. The global warming: manifestation, causes and severity. Perception of climate change.	Systematic exposition - lecture. Conversation. Examples	2 hours
Extened temporal perspective on the actual climate change – Paleoclimatology.	Systematic exposition - lecture. Conversation. Examples	4 hours
Climate models. Design and scientific utility. Weather prediction, climate prediction and climate projections.	Systematic exposition - lecture. Conversation. Examples. Problems.	4 hours
General circulation of atmosphere and ocean.	Systematic exposition - lecture. Conversation. Examples. Problems.	4 hours
Critical components of the climate system.	Systematic exposition - lecture. Conversation. Examples	2 hours
Thermohaline circulation. Socio-economic implications of climate change.	Systematic exposition - lecture. Conversation. Examples	2 hours
Review of the concepts and notions presented during the course.	Systematic exposition - lecture. Conversation. Examples	2 hours

Bibliography:
- IPCC report 2021 (https://www.ipcc.ch/report/ar6/wg1/).
- Holton J., R., Hakim, K. J., 2004: An Introduction to dynamic meteorology, Academic Press.
- Peixoto J and Oort K.,J., 1998: Physics of Climate, Ed New York, pp. 650.

8.2. Tutorials [main themes]	Teaching and learning techniques	Observations

Bibliography: ...whatever you decide to indicate...		
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
▪ Common structures of climate data files ▪ Basic concepts of the GRADS application, used to plot global climate data ▪ Types of plots in GRADS ▪ Computing with GRADS ▪ Analyzing data with GRADS ▪ Visualizing global warming in GRADS ▪ Constructing climate indices with GRADS ▪ Statistical methods used in climate science. Correlation and regression	Guided practical activity	20 hours
Laboratory examination	Reports of practical works and oral examination	4h
Bibliography: ▪ Climate Explorer (http://climexp.knmi.nl/start.cgi) ▪ GRADS (http://cola.gmu.edu/grads/) ▪ Wilks, D. S., Statistical Methods in the Atmospheric Sciences, Academic Press (2006). ▪ IPCC report 2021 (https://www.ipcc.ch/report/ar6/wg1/).		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
Bibliography: ...whatever you decide to indicate...		

9. 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 forms competences and abilities which are important for an undergraduate student in the field of modern Physics, corresponding to national and international standards. 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/expectations of the main employers of the graduates.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of knowledge and theminology used in thermal physics - ability to indicate/analyse specific examples - correct use of equations/mathematical methods/physical models and theories	1. Partial examination. Written test examination of theoretical competences. 2. Final examination. Written and oral test examinations of theoretical competences	30% 40%
10.5.1. Tutorials			
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to analyse and interpret the characterization data - ability to present and discuss the results	Examination of Lab reports	30%
10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam			

Fulfillment of at least 50% of each of the criteria that determine the final grade.
Requirements for mark 5 (10 points scale) Completion of 80% laboratory and mark 5 to the colloquium Minimal knowledge of the theoretical concepts and of the practical works such as: Thermodynamic system. Properties of state and process variable. General expression of first and second law of thermodynamics and their applications for isoprocesses. Thermal and caloric coefficient. Heat engines efficiency.

Date 21.10.2021	Teacher's name and signature Prof dr. Mihai Dima	Practicals/Tutorials instructor(s) name(s) and signature(s) Prof. dr. Mihai Dima

Date of approval
11.11.2021

Head of Department
Prof. dr. Alexandru Jipa

DO.310F.1.EN Semiconductor physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Semiconductor physics								
2.2. Teacher				Prof.dr. Lucian Ion					
2.3. Tutorials/Practicals instructor(s)				Conf.dr. George-Alexandru Nemneş, Prof.dr. Lucian Ion					
2.4. Year of study	3	2.5. Semester	6	2.6. Type of evaluation	E	2.7. Classification of course unit	Content 1)	DS	
							Type 2)	DO	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	5	distribution:	Lectures	2	Tutorials	1	Practicals	2
3.2. Total hours per semester	**50**	distribution:	Lectures	20	Tutorials	10	Practicals	10

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	25
3.3.2. Research in library, study of electronic resources, field research	25
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	21
3.3.4. Examination	4
3.3.5. Other activities	-

3.4. Total hours of individual study	71
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Courses: Electricity and magnetism, Quantum Mechanics I, Equations of mathematical physics, Electrodynamics and Relativity theory, Thermodynamics and Statistical mechanics, Solid state physics, Equations of Mathematical Physics
4.2. competencies	Abilities of Computational Physics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC)

5.2. for practicals/tutorials/projects	Seminar room/specific laboratory infrastructure

6. Specific competences acquired

Professional competencies	Proper identification and use of basic laws, notions and principles specific for condensed matter physics Solving physics problems under given circumstances Performing Physics experiments using standard lab equipment and evaluating the results based on theoretical models Applying creatively the acquired knowledge toward understanding and modeling the processes and physical properties of condensed matter Communication and analysis of scientific information in physics Using specific software packages for data analysis and processing
Transversal competencies	Efficient use of information sources and communication and training resources in an international language Accomplishing professional tasks in an efficient and responsible manner by abiding to legislation and specific ethical and deontological rules, under supervised assistance

7. Course objectives

7.1. General objective	Knowledge of phenomena and specific physical properties of Semiconductor physics
7.2. Specific objectives	The study of kinetic phenomena in semiconductors. Study of the optical properties of semiconductors. Presenting in each chapter the applications of the studied phenomenon and solving some problems that will allow the student to understand the phenomena and form a creative way of thinking, essential for solving practical problems.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Kinetic phenomena. Fundamental coefficients of transport in semiconductors	Systematic exposition - lecture. Examples	6 hours
Hall effect. Magnetoresistant effect	Systematic exposition - lecture. Examples	4 hours
The fundamental transport equations	Systematic exposition - lecture. Examples	2 hours
Shockley-Read statistics. Recombination rate associated with the deep levels.	Systematic exposition - lecture. Examples	4 hours
The optical properties of semiconductors	Systematic exposition - lecture. Examples	4 hours
Bibliography: ▪ P.S. Kireev, *Fizica semiconductorilor* (Editura Științifică și Enciclopedică, București, 1977). ▪ K.W. Boer, U.W Pohl, *Semiconductor Physics* (Springer, Berlin, Germany, 2018). ▪ P.Y. Yu, M. Cardona, Fundamentals of Semiconductors – Physics and Materials Properties *Introduction to Modern Solid State Physics*, (Springer, Berlin, Germany, 2010) ▪ I. Munteanu, *Fizica solidului*, (Editura Universității din Bucureşti, București, 2003). ▪ L. Ion, *Note de curs* (pdf)		
8.2. Tutorials	Teaching and learning techniques	Observations
Electronic semiconductor structure. Doped semiconductors.	Theoretical exposition. Problem solving	2 hours
Hall effect, temperature dependence. The mobility of load carriers.	Theoretical exposition. Problem solving	2 hours
Recombination rate in the presence of deep-level impurities.	Theoretical exposition. Problem solving	2 hours
The fundamental optical absorption	Theoretical exposition. Problem solving	2 hours
Hall effect. Magnetoresistant effect.	Theoretical exposition. Problem solving	2 hours

Bibliography: ▪ K.W. Boer, U.W Pohl, *Semiconductor Physics* (Springer, Berlin, Germany, 2018). ▪ P.Y. Yu, M. Cardona, Fundamentals of Semiconductors – Physics and Materials Properties *Introduction to Modern Solid State Physics*, (Springer, Berlin, Germany, 2010) ▪ I. Munteanu, L. Ion, N. Tomozeiu, "*Fizica semiconductorilor în probleme şi exerciţii*" (Ed. Universităţii din Bucureşti, Bucureşti, 1994) ▪ D. Dragoman, Note de curs (pdf)

8.3. Practicals	Teaching and learning techniques	Observations
The Seebeck effect	Guided practical activity	2 hours
The Peltier effect		2 hours
The optical absorption spectroscopy - determination of the bandwidth of the prohibited semiconductor band	Guided practical activity	2 hours
Study of centers of impurity by electronic spin resonance	Guided practical activity	2 hours
The I-V characteristic of the p-n junction	Guided practical activity	2 hours
Bibliography: ▪ C. Berbecaru, L. Ion, Fizica solidului – Caiet de lucrări de laborator • C. Kittel, Introduction to Solid State Physics (8th ed., John Wiley & Sons, New York, 2004). ▪ K.W. Boer, U.W Pohl, *Semiconductor Physics* (Springer, Berlin, Germany, 2018). ▪ P.Y. Yu, M. Cardona, Fundamentals of Semiconductors – Physics and Materials Properties *Introduction to Modern Solid State Physics*, (Springer, Berlin, Germany, 2010) ▪ I. Munteanu, L. Ion, N. Tomozeiu, "*Fizica semiconductorilor în probleme şi exerciţii*" (Ed. Universităţii din Bucureşti, Bucureşti, 1994) ▪ D. Dragoman, Note de curs (pdf)		

8.4. Project Not Applicable	Teaching and learning techniques	Observations
Bibliography:		

9. 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 content is in agreement with the content of similar courses taught at national and international universities, such as University Babeş-Bolyai, Cluj Napoca, University „Alexandru Ioan Cuza", Iași and, respectively, University of Groningen, Netherlands, Warwick University, UK, University of Tubingen, Germany, Technical University Wien, Austria, etc. The course forms abilities and competences to analyze the physical phenomena specific to semiconductors, to plan and carry out specific experiments and to identify applications, skills and abilities of interest for companies and research institutes with activity in Materials Physics as well as in secondary school teaching.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	Clarity, coherence and concision of exposition; Proper use of physical models and mathematical formalism; Capacity of exemplification; Capacity to apply the acquired knowledge to problem solving.	Written exam	60%
10.5.1. Tutorial	Application of specific solving methods for a given problem	On-going evaluation; solving of given homeworks	20%
10.5.2. Practical	Proper use of physical models and mathematical formalism; Knowledge of specific experimental techniques and instrumentation	Lab colloquium	20%
10.5.3. Project	Not applicable	Not applicable	Not applicable
10.6. Minimal requirements for passing the exam Attendance at all practical and tutorial activities and mark 5 at the corresponding evaluations			

Solving of selected subjects for mark 5 at the final written exam Obtaining a grade of 5 at the laboratory colloquium. Requirements for getting mark 10 (10 points scale) Skills, well-argued knowledge Demonstrated ability to analyze phenomena and processes

Date
05.11.2021

Teacher’s signature
Prof.dr. Lucian Ion

Practicals/Tutorials instructor’s signature
Conf.dr. George Alexandru Nemneș

Date of approval
11.11.2021

Head of Department
Conf.dr. Adrian Radu

DO 311.2F.EN Advanced in solid state

1. Study program

1.1. University	University of Bucharest
o 1.2. Faculty	Faculty of Physics
1.3. Department	Department of Electricity, Solid State Physics and Biophysics
1.4. Field of study	Exact and natural sciences / Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Advanced in solid state physics								
2.2. Teacher				Assoc. Prof. George Alexandru Nemneș					
2.3. Tutorials/Practicals instructor(s)				Assoc. Prof. George Alexandru Nemneș					
2.4. Year of study	3	2.5. Semester	6	2.6. Type of evaluation	E	2.7. Type of course unit	Content [1]	DF	
							Type [2]	DO	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	1	Practicals	2	Project	0
3.2. Total hours per semester	50	distribution:	Lectures	20	Tutorials	10	Practicals	20	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	20
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	31
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	71
3.5. Total hours per semester	125
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Lectures: Solid state physics, Quantum mechanics, Electricity and magnetism, Optics
4.2. competences	Use of software packages for data analysis

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC)

5.2. for practicals/tutorials/projects	Equipments for electrical, optical and magnetic characterizations. Workstations with Linux operating system.

6. Specific competences acquired

Professional competences	C1 – Identification and correct use of physical laws and principles in given contexts C3 – Solving of physics problems in imposed conditions C4 – Performing of physics experiments by using standard laboratory equipments C5 – Analysis and communication/presentation of scientific data
Transversal competences	CT3 – Efficient use of the sources of scientific information and communication of scientific data in English

7. Course objectives

7.1. General objective	Study of advanced topics in the physics of crystalline solids
7.2. Specific objectives	- Knowledge of specific physical theories and models used in advanced solid state physics - Developing the ability to creatively use specific physical models to solve problems and analyze experimental data - Knowledge and use of specific experimental characterization methods

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Physics of nanostructures. Introduction. Specific electrical and optical properties.	Systematic exposition - lecture. Examples.	4 hours
Magnetic properties of solids. Applications. Spintronics.	Systematic exposition - lecture. Examples.	4 hours
Introduction to fractional exclusion statistics. Applications	Systematic exposition - lecture. Examples.	4 hours
Atomistic methods for electronic properties of materials	Systematic exposition - lecture. Examples.	4 hours
Machine learning techniques in condensed matter physics.	Systematic exposition - lecture. Examples.	4 hours
Bibliography: - D.K. Ferry, S.M. Goodnick, Transport in Nanostructures (Cambridge Univ. Press, 2009, 2nd ed) - S. Datta Electronic transport in Mesoscopic systems (Cambridge Univ. Press, Reprinted 1999) - Electronic Structure – Basic Properties and Practical Methods (Cambridge Univ. Press, 2020)		
8.2. Tutorials	Teaching and learning techniques	Observations
Determination of electron transmission coefficients in low-dimensional structures [Examples]	Seminar	2 hours
Rashba effect. Spin filters. [Examples]	Seminar	2 hours
Applications of fractional exclusion statistics to interacting fermion and boson systems. [theoretical aspects]	Seminar	2 hours
Atomistic calculation of semiconductor band structures [theoretical aspects]	Seminar	2 hours
Artificial neural networks for predicting electronic properties. [Usage of specialized libraries]	Seminar	2 hours
Bibliography: - D.K. Ferry, S.M. Goodnick, Transport in Nanostructures (Cambridge Univ. Press, 2009, 2nd ed) - S. Datta Electronic transport in Mesoscopic systems (Cambridge Univ. Press, Reprinted 1999) - Electronic Structure – Basic Properties and Practical Methods (Cambridge Univ. Press, 2020) - TensorFlow: https://www.tensorflow.org/		

8.3. Practicals	Teaching and learning techniques	Observations
Determination of electron transmission coefficients in low-dimensional structures. [Applied scattering theory]	Guided practical activity	4 hours
Rashba effect. Spin filters. [Applied scattering theory]	Guided practical activity	4 hours
Applications of fractional exclusion statistics to interacting fermion and boson systems. [Metropolis algorithm for transition rates]	Guided practical activity	4 hours
Atomistic calculation of semiconductor band structures. [SIESTA code]	Guided practical activity	4 hours
Artificial neural networks for predicting electronic properties. [TensorFlow, SciKit Learn applications]	Guided practical activity	4 hours
Bibliography: - D.K. Ferry, S.M. Goodnick, Transport in Nanostructures (Cambridge Univ. Press, 2009, 2nd ed) - S. Datta Electronic transport in Mesoscopic systems (Cambridge Univ. Press, Reprinted 1999) - Electronic Structure – Basic Properties and Practical Methods (Cambridge Univ. Press, 2020) - TensorFlow: https://www.tensorflow.org/		

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 aims at developing specific theoretical and practical competences and abilities in the field of advanced solid state physics, corresponding to national and european/international standards. 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/expectations of the main employers of the graduates (industry, research – e.g. the National R&D Institute for Materials Physics, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyze specific examples	Written exam	50%
10.5.1. Tutorial	- ability to solve problems	Homeworks	25%
10.5.2. Practical	- ability to design and perform specific experiments - ability to present and discuss the results	Colloquium	25%
10.5.3. Project			
10.6. 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: transmission functions and ballistic transport in nanostructures, spin filter effects, setup of an atomistic model, working principles of artificial neural networks. Minimum participation: 50% lectures and 100% labs. For online evaluations, the exam subjects shall be sent via email / Google Meet / Google Classroom / Microsoft Teams. During the exam the students shall have the camera on. The exam shall be recorded.			

Date 2.11.2021	Teacher’s name and signature Assoc. Prof. George Alexandru Nemnes	Practicals/Tutorials instructor(s) name(s) and signature(s) Assoc. Prof. George Alexandru Nemnes,
Date of approval 11.11.2021	Head of Department Assoc. Prof. Adrian Radu	

DO.311F.1.EN Electronic devices and circuits

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	Physics
1.5.Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Electronic devices and Circuits							
2.2. Teacher				Assoc Prof. RADU				
2.3. Tutorials/Practicals instructor(s)				Assoc. Prof. RADU				
2.4. Year of study	3	2.5. Semester	6	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DO

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Project	0
3.2. Total hours per semester	40	distribution:	Lectures	20	Tutorials	0	Practicals	20	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	30
3.3.2. Research in library, study of electronic resources, field research	30
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	21
3.3.4. Examination	4
3.3.5. Other activities	0

3.4. Total hours of individual study	81
3.5. Total hours per semester	125
3.6. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and Magnetism, Real and Complex Mathematica Analysis
4.2. competencies	Use of software packages for data analysis and visualization

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Course room, projector, screen
5.2. for practicals/tutorials/projects	Lab room, experimental setups, power supplies, measurement instruments, oscilloscopes

6. Specific competences acquired

Professional competencies	Ability to describe physical systems, using theoretical approaches and appropriate instruments Ability to compare the results of numerical models and simulations with literature data or experimental measurements. Critical evaluation of the results of the implementation of physical models, including the uncertainity

	in experimental data. Ability to implement, improve and extend the use of a physical model. Ability to design and implement experimental setups and devices capable of validating a physical model.
Transversal competencies	Efficient and responsible fulfillment of the professional duties, while respecting the deontological laws of the domain, under qualified supervision. Efficient use of informational, communication and guided professional development resources in Romanian and another widespread foreign language.

7. Course objectives

7.1. General objective	An introduction to electronics: description of the main circuits and devices used in lab room; highlighting of dynamic and static characteristics; highlighting of design and construction parameters; highlighting of circuit components; exposition of dedicated measurement techniques; exhibition of suitable means of calculating various physical parameters
7.2. Specific objectives	Study of the most frequently used semiconductor devices and study of the related physical processes involved. Applications. Study of various electronic circuits and study of the related physical processes involved. Applications. Systematic and logic way exposition of the physical phenomena and processes involved so that to allow to student to solve future difficulties in this field.

8. Contents

8.1. Lectures[chapters]	Teaching techniques	Observations
Common collector amplifier, voltage gain, input, and output impedance. Boot-strap method for increasing input impedance. Applications.	Systematic exposition - lecture. Examples	4 hours
Common collector amplifier, voltage gain, input, and output impedance. Applications	Systematic exposition - lecture. Examples	4 hours
The power level of bipolar junction transistors. Working levels. Opposite working level. Distortions	Systematic exposition - lecture. Examples	4 hours
Electronic circuits feedback	Systematic exposition - lecture. Examples	2 hours
Delay time oscillators.	Systematic exposition - lecture. Examples	2 hours
Comparisons with hysteresis.	Systematic exposition - lecture. Examples	2 hours
Positive selective feedback of electronic circuits. Sinusoidal oscillators. Studies of how to stabilize the oscillation amplitude. Applications.	Systematic exposition - lecture. Examples	2 hours
Bibliography: - Mihai P Dinca, "Electronica - Manualul studentului", vol1, Editura Universitatii din Bucuresti, 2003. - C. Alexander and M. Sadiku, "Fundamentals of electric circuits", McGraw-Hill, 2009 - R. Dorf and J. Svoboda, "Introducton to electric circuits", John Wiley & Sons, 2010 - R. Boylestad and L. Nashelsky, "Electronic devices and circuit theory", Prentice Hall - T. Floyd, "Electronic devices", Pearson Education, 2005 - P. Horowitz and W. Hill, "The art of electronics", 2nd edition, Cambridge Unversity Press,1994		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
Common collector amplifier	Guided practical activity	4 hours
Common base amplifier.	Guided practical activity	4 hours
Power amplifier.	Guided practical activity	4 hours
Relaxation oscillator	Guided practical activity	2 hours

Integrated comparators	Guided practical activity	2 hours
Sine oscillators	Guided practical activity	4 hours
Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 sketch the contents, to choose the teaching/learning methods, the holders of the discipline consulted the content of similar disciplines taught at universities in the country and abroad. The content of the discipline is in line with the standards used in research and industry.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	Clarity, coherence, and conciseness of the presentation; - Correct use of calculation relations; - Ability to exemplify; - Applying specific methods for solving the given problem;	Written exam and oral assessment	70%
10.5.1. Tutorial			
10.5.2. Practical	- Applying specific methods for solving the given problem; - Interpretation of results;	Laboratory colloquium	30%
10.5.3. Project			
10.6. 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.			

Date	Teacher's name and signature	Practicals/Tutorials instructor(s) name(s) and signature(s)
9.11.2021	Assoc. Prof. Adrian RADU	Assoc. Prof. Adrian RADU

Date of approval
11.11.2021

Head of Department
Assoc. Prof. Adrian RADU

DO.311F.2 Introduction to Nanotechnologies

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Introduction to Nanotechnologies
2.2. Teacher	Associate Professor Ph.D. Eng. Vlad-Andrei ANTOHE
2.3. Tutorials/Practicals instructor(s)	Associate Professor Ph.D. Sorina IFTIMIE

2.4. Year of study	3	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Type of course unit	Content[1)]	DS
							Type[2)]	DO

[1)] fundamental (DF), speciality (DS), complementary (DC); [2)] compulsory (DI), elective (DO), optional (DFac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution: Lecture	2	Tutorials / Practicals	2
3.2. Total hours per semester	40	distribution: Lecture	o 20	o Tutorials / Practicals	20
Distribution of estimated time for study					hours
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography					35
3.2.2. Research in library, study of electronic resources, field research					15
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks					25
3.2.4. Examination					4
3.2.5. Other activities					6

3.3. Total hours of individual study	81
3.4. Total hours per semester	125
3.5. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	DFC.102F.EN – General Chemistry DI.113F.EN – Electricity and Magnetism DI.201F.EN – Optics DI.210F.EN – Electronics DI.303F.EN – Solid State Physics DI.107F.EN, DI.115F.EN and DI.206F.EN – Scientific English
4.2. competences	DFC.101F.EN – Object oriented programming Basic skills of handling small laboratory equipment and tools. Basic skills of data analysis and processing using dedicated software packages.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia room (Video-beamer, PC, Internet connectivity)
5.2. for practicals/tutorials	Laboratory (place): MDEO research infrastructure, Nanotechnologies Lab. Requirements: experimental settings for carrying out basic experiments on the preparation and characterization of nanomaterials

6. Specific competences acquired

Professional competences	C1 – Identify and make appropriate use of the main laws and principles of physics, in a given context. C3 – Make use of computers and data acquisition boards to control basic experiments or processes, and automation of experimental data collection. C4 – Carry out basic experiments in physics by using specific laboratory equipment. C5 – Analyze and communicate basic scientific, educational and popular information on physics.
Transversal competences	CT3 – Efficient use of trusted sources of scientific information and proficient communication of scientific data in English

7. Course objectives

7.1. General objective	Establishing the grounding of nanoscale sciences and technologies, as well as the basics for more advanced lectures in the field of preparation and characterization of nanomaterials and low-dimensional systems.
7.2. Specific objectives	- Getting basic knowledge on the preparation and characterization of nanostructured materials. - Getting insights into the use of nanomaterials within electronic and optoelectronic devices. - Getting basic skills on the laboratory working environment, as well as on the acquisition and interpretation of experimental data.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations

Introduction into the nanoscale science and technology ▪ Emergent applications and nanotechnologies ▪ Examples. Evolution of the computing systems ▪ Breakthrough applications of nanotechnology	Systematic exposition – Lecture. Critical discussions. Examples.	4 hours
Nanomaterials and low-dimensional systems ▪ Nanotechnology. Basic concepts and definitions ▪ Length's scale. Classification of nanostructures ▪ Physical effects at nanometer scale	Systematic exposition – Lecture. Critical discussions. Examples.	4 hours
Preparation of nanomaterials and nanostructures ▪ Contamination in nanotechnology ▪ Cleanrooms. Classification and standards ▪ Cleanroom basic processes. Overview	Systematic exposition – Lecture. Critical discussions. Examples.	4 hours
Synthesis of thin films and nanomaterials ▪ Basics on thin film deposition techniques ▪ Electrochemical processes in nanotechnology ▪ Surfaces manipulation and patterning	Systematic exposition – Lecture. Critical discussions. Examples.	4 hours
Processing and manufacturing of silicon wafers ▪ Semiconducting silicon. Structural properties ▪ Fabrication of mono-crystalline silicon wafers ▪ Filed-effect transistors. Microchips design	Systematic exposition – Lecture. Critical discussions. Examples.	4 hours
Bibliography: 1. V. A. Antohe, "Capacitive Sensors Based on Localized Nanowire Arrays. Nanotechnology & Device Integration Routes", Lambert Academic Publishing (LAP), 244 Pages, ISBN: 978-3-659-38899-6 (May 2013); 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.		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
-	-	-
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
Vacuum thermal evaporation of metallic thin films	Guided practical activity	4 hours
RF magnetron sputtering of inorganic thin films	Guided practical activity	4 hours
Spin-coating processes of organic thin films	Guided practical activity	4 hours
Nanomaterials synthesis by electrochemical processes	Guided practical activity	4 hours
Morphological characterization of thin films and nanomaterials	Guided practical activity	4 hours
Bibliography: Laboratory practical sessions' booklet: 1. S. Antohe, L. Ion, F. Stanculescu, S. Iftimie, A. Radu and **V. A. Antohe**, "Fizica și tehnologia materialelor semiconductoare – Lucrări practice", Ars Docendi, Universitatea din București, ISBN: 978-973-558-940-0 (2016) Research papers linked to the content of this course unit: 1. O. Toma, **V. A. Antohe**, A. M. Panaitescu, S. Iftimie, A. M. Răduță, A. Radu, L. Ion and Ș. Antohe, "Effect of RF Power on the Physical Properties of Sputtered ZnSe Nanostructured Thin Films for Photovoltaic Applications", Nanomaterials 11(11), 2841 (2021), doi: 10.3390/nano11112841 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		
8.4. Project [only if included in syllabus]	Teaching and learning techniques	Observations
-	-	-
Bibliography: -		

9. 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 aims at developing specific theoretical competences and practical abilities in the field of nanoscale sciences and technologies. The content corresponds to all national and European/international standards. The content of lectures and the teaching methods were carefully selected and framed after the content of similar course units within internationally-recognized universities from Romania and European Union (Leibniz Universität Hannover – Germany and Université Catholique de Louvain – Belgium). All lectures and the proposed experiments comply with the high standards requirements and expectations of our main employers of the graduates (industry sector, research institutes – i.e., National Institute of Materials Physics, elementary and high school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Coherence and clarity of exposition	Written test / Oral examination	30% / 30%
10.5.2. Practicals	- Ability to use specific experimental settings and equipment - Ability to perform specific experiments and to interpret scientific data - Ability to present and discuss the scientific results	Laboratory colloquium	40%
10.6. Minimal requirements for passing the exam -			
Requirements for mark 5 (10 points scale) - Carrying out all mandatory experiments and passing the laboratory colloquium - Correct answer to basic questions			

Date
12.10.2021

Teacher's name and signature Assoc. Prof. Ph.D. Eng. Vlad-Andrei ANTOHE

Practical instructor, name(s) and signature(s)
Assoc. Prof. Ph.D. Sorina IFTIMIE

Date of approval
11.11.2021

Head of Department,
Assoc. Prof. Ph.D. Adrian RADU

Optional courses

DFC.101F.EN Object oriented programming

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Structure of Matter, Physics of Earth and Atmosphere, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Object oriented programming							
2.2. Teacher				Lect. Univ. Dr. Marius Călin/Lect.Univ.Dr. Alecsandru Chiroșca				
2.3. Tutorials/Practicals instructor(s)				Lect. Univ. Dr. Marius Călin/Lect.Univ.Dr. Alecsandru Chiroșca				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DFac

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	0	Practicals	2	Proje ct	0
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	0	Practicals	28	Proje ct	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	20
3.3.2. Research in library, study of electronic resources, field research	10
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	10
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competencies	High school mathematics, fundamental algorithms

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Video projector
5.2. for practicals/tutorials/projects	Computer room

6. Specific competences acquired

Professional competencies	– Using of dedicated software for data analysis and processing - Solving physics problems in given conditions, using different OOP languages – Interdisciplinary approach of some physics problems
Transversal competencies	- Efficient use of information and communication resources available.

7. Course objectives

7.1. General objective	Getting acquitted with computer programming basics, especially with C/C++, Python, Java, C# programming language. Developing algorithms for solving physical problems.
7.2. Specific objectives	- knowledge of objects oriented programming languages specifics; physical theories/models - developing the ability of modeling and solving physical problems; - using the computing skills for experimental and theoretical applications

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
- Hardware. Computer architecture. Binary system. - Software. Operation systems and programming languages. Short history. - Correlation between the scientific coding language and the solving problem type: model calculations, simulation, data acquisition and processing. Examples of complex codes. - Scientific languages mostly used in physics: evolution, general characteristics, distinctive features	Systematic exposition - lecture. Examples	2 hours
- Programming stages: problem solving, developing algorithm, implementation, compilation, execution. - The basic of object oriented programming: abstraction, encapsulation, implementation, interface	Systematic exposition - lecture. Examples	6 hours
- C++ programming languages: basic, structure, main characteristics, examples	Systematic exposition - lecture. Examples	4 hours
- Phyton: basic, structure, main characteristics, examples	Systematic exposition - lecture. Examples	4 hours
- Java: basic, structure, main characteristics, examples	Systematic exposition - lecture.	4 hours

	Examples	
- C#: basic, structure, main characteristics, examples	Systematic exposition - lecture. Examples	4 hours
- Examples of codes written in different OOP languages	Systematic exposition - lecture. Examples	4 hours
Bibliography: 1. Bjarne Stroustrup – Principles and Practice Using C++ - Addison – Wesley Publishing Company, 2009 2. Peter Norton, Alex Samuel, David Aitel, Eric Foster-Johnson, etc - Beginning Python, Wiley Publishing, Inc. 2005 3. Ken Arnold, James Gosling, David Holmes - The Java Programming Language, Prentice Hall, 2005 4. Microsoft C# Language Specifications, Microsoft Press, 2001 **5. www.isocpp.org** **6. www.python.org** 7.www.java.com		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
- Introduction in OOP: basic applications	Guided practical activity	2 hours
- Using C++ for programming: applications	Guided practical activity	6 hours
- Using Phyton for programming: applications	Guided practical activity	6 hours
- Using Java for programming: applications	Guided practical activity	6 hours
- Using C## for programming: applications	Guided practical activity	6 hours
- Exemples of complex applications written in different OOP languages	Guided practical activity	2 hours
Bibliography: 1. Bjarne Stroustrup – Principles and Practice Using C++ - Addison – Wesley Publishing Company, 2009 2. Peter Norton, Alex Samuel, David Aitel, Eric Foster-Johnson, etc - Beginning Python, Wiley Publishing, Inc. 2005 3. Ken Arnold, James Gosling, David Holmes - The Java Programming Language, Prentice Hall, 2005 4. Microsoft C# Language Specifications, Microsoft Press, 2001 5. www.isocpp.org 6. www.python.org 7.www.java.com		
8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 practical competences and abilities which are fundamental for an undergraduate student in the field of modern Physics, corresponding to national and European/international standards. 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/expectations of the main employers of the graduates (economy, research, education).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- knowledge, understanding, coherence, logic and clarity of exposition	Written test	45%
10.5.1. Tutorial			
10.5.2. Practical	- ability to model a problem, create an	Computer code	55%

	algorithm, implement it into a functional code written in at least two different OOP language		
10.5.3. Project			
10.6. Minimal requirements for passing the exam **Participation to all practical activities and at least 7 lectures** - -Solving 25% of the written test. - Developing and presenting a code with a low degree of complexity but fully functional in two different OOP languages			

Date
28.10.2021

Teacher's name and signature
Lect. Univ. dr. Marius Călin
Lect. Univ. Dr. Alecsandru Chiroșca

Practicals/Tutorials instructor(s) name(s) and signature(s)
Lect. Univ. dr. Marius Călin
Lect. Univ. Dr. Alecsandru Chiroșca

Date of approval
11.11.2021

Head of Department
Prof.Univ.Dr. Alexandru Jipa

DFC.102F.EN General Chemistry

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	General Chemistry							
2.2. Teacher				Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu				
2.3. Tutorials/Practicals instructor(s)				Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	C	2.7. Classification of course unit	Content [1)]	DC
							Type [2)]	DFC

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials		Practicals	2	Project
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials		Practicals	28	Project

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	13
3.3.2. Research in library, study of electronic resources, field research	12
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	15
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	Use of software packages for data analysis

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC), Internet access
5.2. for practicals/tutorials/projects	Laboratory rooms equipped with: • Modern equipment, instruments and accessories: modern laboratory glassware; Sartorius analytical balance; Analytical balance Kern ABS 220-4N, 220g; Kern precision scales; pipettes; micropipettes; manual and electronic pipetting devices; magnetic stirrers with and without heating; computers; mechanical stirrer (VIBRAX stirrer); pH-meters (stationary: Fisher Scientific; portable: pH 110 Exstik); Conductometer 3110 WTW; ovens with thermostat and electronic display; water purification system Milli-Q (conductivity ≤ 0.1 μS cm^{-1}); Titan probe sonicator Hielscher UP 100H; Ultrasonic bath BRANSON 1210; Water bath with electronic display and recirculation; SIGMA 2-16 K cooling centrifuge; spectrophotometers; UV-Vis single-beam spectrophotometer (model UV-20) ONDA; Temperature sensor with electronic display; Fisher Scientific Vortex Agitator, 1500 rpm; Ostwald viscometer; specific reagents; refrigerator; high-performance air conditioners, etc. • Interactive practical laboratory equipment - Phywe experimental set-up, computer assisted. • Computers with internet connection, tables, video projector, screen, blackboard.

6. Specific competences acquired

Professional competences	Identification and correct use of physical laws and principles in given contexts. Analysis and communication/presentation of scientific data. Interdisciplinary approach of topics in physics.
Transversal competences	Efficient use of the sources of scientific information and communication of scientific data in English

7. Course objectives

7.1. General objective	The aim of this course is to introduce students to the fundamentals of General Chemistry, to understand the concepts of composition, physico-chemical properties and transformations of matter and energy involved in these transformations.
7.2. Specific objectives	Knowledge of specific physical theories and models used in General Chemistry. Using the acquired knowledge to solve specific problems in General Chemistry. Performing and interpretation of experiments.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Introduction to chemistry. Branches of chemistry. The importance of chemistry. Tangency of chemistry with other disciplines. Chemistry laws.	Systematic exposition - lecture. Examples	2 hours
Matter: definition, properties (intensive, extensive), aggregation states. Antimatter. Mixtures: definition, types. Atom: definition, structure, component particles. Atomic orbitals.	Systematic exposition - lecture. Examples	2 hours
Periodic system of elements; the law of periodicity; explaining and interpreting the relationship between the electronic configuration, the position in the periodic table and the specific properties of each element. Electronic configuration (*in extenso* and short). The chessboard rule. The distinctive electron. The valence electrons and the Lewis structure. Metals, non-metals, metalloids: definition, properties, examples. General characterization (physical and chemical properties, applications) of the elements of s, p, d, f blocks. Biologically important elements. Shape memory materials.	Systematic exposition - lecture. Examples. Applications	4 hours
Allotropy; examples of allotropic elements. Carbon nanotubes - applications.	Systematic exposition - lecture. Examples	4 hours
Chemical bonds. Intermolecular interactions	Systematic exposition - lecture. Examples. Applications	2 hours
Water: structure, biological role, unusual properties of water, solvent properties, ionization, pH of solutions.	Systematic exposition - lecture. Examples. Applications	2 hours
Chemical reactions. Classification of chemical reactions. Chemical	Systematic exposition -	4 hours

equations. Establishing stoichiometric coefficients: the algebraic method and the redox method. The chemical equilibria. Notions of thermodynamics and kinetics of chemical reactions.	lecture. Examples. Applications	
Green Chemistry. Principles and applications in engineering, environment, agriculture, nanotechnology, medicine, materials science.	Systematic exposition - lecture. Examples. Critical analysis. Applications	4 hours
General considerations regarding Green Nanotechnology - the science of the future. Bottom-up methods for ecological development of nanomaterials. Applications.	Systematic exposition - lecture. Examples. Critical analysis. Applications	4 hours

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- Gorshkova, Y.; **Barbinta-Patrascu, M.-E.***; Bokuchava, G.; Badea, N.; Ungureanu, C.; Lazea-Stoyanova, A.; Răileanu, M.; Bacalum, M.; Turchenko, V.; Zhigunov, A.; Juszyńska-Gałązka, E. Biological Performances of Plasmonic Biohybrids Based on Phyto-Silver/Silver Chloride Nanoparticles. ***Nanomaterials*** 11(7), 1811, **2021**. (**Q1**; **IF_{2020}= 5.076; AIS_{2020}=0.759**)
- Mironescu, M.; Lazea-Stoyanova, A.; **Barbinta-Patrascu, M.E.***; Virchea, L.-I.; Rexhepi, D.; Mathe, E.; Georgescu, C., Green Design of Novel Starch-Based Packaging Materials Sustaining Human and Environmental Health. ***Polymers*** 13, 1190, **2021**. (**Q1**; **IF_{2020}= 4.329; AIS_{2020} = 0.599**)
- **Marcela-Elisabeta Barbinta-Patrascu,** Mihaela Bacalum, Vlad-Andrei Antohe, Sorina Iftimie, Stefan Antohe, Bio-nanoplatinum phyto-developed from grape berries and nettle leaves: potential adjuvants in osteosarcoma treatment, ***Rom.Rep.Phys.*** 74(1), **2022**. (Q3; **IF_{2020}= 1.785**; **AIS_{2020}= 0.268**)
- **Marcela-Elisabeta Barbinta-Patrascu**, N. Badea, M. Bacalum, C. Ungureanu, I. R. Suica-Bunghez, S. M. Iordache, C. Pirvu, I. Zgura, V. A. Maraloiu, 3D hybrid structures based on biomimetic membranes and *Caryophyllus aromaticus* - "green" synthesized nano-silver with improved bioperformances, ***Materials Science & Engineering C-Materials For Biological Applications*** 101, 120-137, **2019.** (**Q1**; **IF_{2019} = 5.88; AIS_{2019} = 0.794**).
- **Marcela-Elisabeta Barbinta-Patrascu**, Nicoleta Badea, Camelia Ungureanu, Stefan Marian Iordache, Marioara Constantin, Violeta Purcar, Cristian Pirvu and Ileana Rau, *Eco-Biophysical Aspects on Nanosilver Bio-Generated from Citrus reticulata Peels, as Potential Bio-Pesticide for Controlling Pathogens and Wetland Plants in Aquatic Media*, ***Journal of Nanomaterials***, vol. 2017, Article ID 4214017, **2017**. (**Q2**; **IF_{2017} = 2.207; AIS_{2017} = 0.565**).

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
Instructions for safety and health at work for activities in General Chemistry lab.	Systematic exposition - lecture. Conversations. Examples. Applications. Guided practical activity	1 hour
Familiarization with laboratory equipment and accessories.	Guided practical activity	1 hour
Types of concentrations; measurement units. Solving problems.	Systematic exposition -	3 hours

Preparation of solutions of a certain concentration. Successive dilutions. Mixtures.	lecture. Conversations. Examples. Applications. Guided practical activity	
Measurement of pH of water samples	Guided practical activity	2 hours
Measurement of conductivity of water samples	Guided practical activity	2 hours
Finding the formula for hydrated copper (II) sulfate.	Guided practical activity	2 hours
Chemical reactions (neutralization, decomposition, precipitation, redox processes)	Guided practical activity	4 hours
Ecological methods for obtaining metal nanoparticles, using the principles of "Green Chemistry" - phytosynthesis. Spectral characterization. Solving specific problems.	Guided practical activity. Applications.	5 hours
Preparation of bioplastic from plant materials.	Guided practical activity	4 hours
Discussing laboratory reports. Solving problems and tests of General Chemistry.	Conversations. Examples. Applications	4 hours

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- **Marcela-Elisabeta Barbinta-Patrascu**, Camelia Ungureanu, Nicoleta Badea, Mihaela Bacalum, Andrada Lazea-Stoyanova, Irina Zgura, Catalin Negrila, Monica Enculescu and Cristian Burnei, Novel Ecogenic Plasmonic Biohybrids as Multifunctional Bioactive Coatings, ***Coatings*** 10, 659, **2020**; WOS:000556474000001.
- **Marcela Elisabeta Barbinta-Patrascu**, Nicoleta Badea, Mihaela Bacalum, Camelia Ungureanu, Ioana Raluca Suica-Bunghez, Stefan Marian Iordache, Cristian Pirvu, Irina Zgura, Valentin Adrian Maraloiu, 3D hybrid structures based on biomimetic membranes and *Caryophyllus aromaticus* - "green" synthesized nano-silver with improved bioperformances, ***MATERIALS SCIENCE & ENGINEERING C-MATERIALS FOR BIOLOGICAL APPLICATIONS*** 101, 120-137, **2019.** DOI: 10.1016/j.msec.2019.03.069, WOS:000471359100012; https://doi.org/10.1016/j.msec.2019.03.069 (**IF = 5.88 / 2019**).
- **Marcela-Elisabeta Barbinta-Patrascu**, Nicoleta Badea, Camelia Ungureanu, Marioara Constantin, Cristian Pirvu, Ileana Rau. Silver-based biohybrids "green" synthesized from *Chelidonium majus* L., *Opt. Mat*., 56 (2016) 94–99.
- **M. E. Barbinta-Patrascu**, I.R. Bunghez, S. M.Iordache, N. Badea, R.C. Fierascu, R.M. Ion, Antioxidant Properties of Biohybrids Based on Liposomes and Sage Silver Nanoparticles, *Journal of Nanoscience and Nanotechnology*, 13, 2051 – 2060, 2013**.**
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8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 aims at developing specific theoretical and practical competences and abilities in the field of General Chemistry, corresponding to national and european/international standards. 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 (Babes-Bolyai University, Cluj-Napoca) or from abroad (University of Coimbra; Rutgers University; University of Southampton; University of Cambridge). The contents are in line with the requirements/expectations of the main employers of the graduates (industry, research in Physics – e.g. the National R&D Institute for Materials Physics, secondary school teaching).

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/and theories - ability to indicate/analyse specific examples	Written test	60%
10.5.1. Tutorial			
10.5.2. Practical	- ability to perform specific experiments - ability to present and discuss the results - ability to use specific problem solving methods - ability to analyse the results	Lab reports; practical evaluation	40%
10.5.3. Project			
10.6. Minimal requirements for passing the exam Attendance at least 50% of the number of lectures and compulsory attendance at all laboratory sessions. Completion of all work and laboratory reports. Correct solution for the subjects indicated to obtain score 5 at the final colloquium.			

Date 27.10.2021	Teacher's name and signature Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu	Practicals/Tutorials instructor(s) name(s) and signature(s) Assoc.Prof. dr. eng. Marcela-Elisabeta Bărbînţă-Pătraşcu

Date of approval

Head of Department

11.11.2021 Assoc.Prof.Dr. Adrian Radu

DFC.201F.EN Parallel computer architecture and programming

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Semiconductor physics								
2.2. Teacher				Prof.dr. Lucian Ion					
2.3. Tutorials/Practicals instructor(s)				Asist.dr. Geanina Chiroșca					
2.4. Year of study	2	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS	
							Type [2)]	DFac	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	-	Practicals	2
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	-	Practicals	28
3.3 Distribution of estimated time for study								hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography								15
3.3.2. Research in library, study of electronic resources, field research								10
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks								15
3.3.4. Examination								4
3.3.5. Other activities								-

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Courses: Computer Programming (C/C++)/
4.2. competencies	Knowledge of basic numerical techniques and methods

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (videoprojector, PC)
5.2. for practicals/tutorials/projects	Laboratory with specific infrastructure (networked computing systems)

6. Specific competences acquired

Professional competencies	Creative application of the acquired knowledge in order to understand and to modeling physical processes and phenomena; Processing and analysis of experimental data and use / development of specific software tools; Development and use of computer applications and virtual instrumentation to solve various physics problems; Communication and analysis of scientific information in physics Using specific software packages for data analysis and processing

Transversal competencies	Efficient use of information sources and communication and training resources in an international language Accomplishing professional tasks in an efficient and responsible manner by abiding to legislation and specific ethical and deontological rules, under supervised assistance

7. Course objectives

7.1. General objective	Knowledge of the architecture of parallel computing systems and the main techniques of parallel programming
7.2. Specific objectives	Knowledge of the characteristics of parallel computing architectures Knowledge of the general characteristics of parallel computing models Knowledge of MPI programming techniques Knowledge of OpenMP programming techniques Forming a creative way of thinking, essential for solving practical problems.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Concepts and fundamental elements. Classification of parallel computing architectures.	Systematic exposition - lecture. Examples	6 hours
General characteristics of parallel computing models. Performance indicators.	Systematic exposition - lecture. Examples	4 hours
The MPI standard. MPI programming techniques.	Systematic exposition - lecture. Examples	10 hours
OpenMP programming techniques	Systematic exposition - lecture. Examples	8 hours
Bibliography: ▪ Michael J. Quinn, *Parallel Programming in C with MPI and OpenMP* (McGraw-Hill, New York, USA, 2003). ▪ T. Rauber, G. Runger, *Parallel Programming for multicore and cluster systems* (Springer-Verlag, Berlin, Germany, 2010). ▪ W. Gropp, E. Lusk, A. Skjellum, Using MPI: portable parallel programming with the Message-Passing Interface (MIT Press, Cambridge, USA, 2014). ▪ L. Ion, *Note de curs* (pdf)		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
Function libraries for implementing simple process communication between processes	Guided practical activity	5 hours
Functions for managing the MPI environment. One-to-one communication operations	Guided practical activity	3 hours
Groups and communicators in the MPI environment. Virtual process topologies	Guided practical activity	6 hours
Derived data types. One-way communication and synchronization.	Guided practical activity	5 hours
Dynamic process creation and management. Parallel I / O operations.	Guided practical activity	3 hours
Threaded programming. The OpenMP standard	Guided practical activity	6 hours
Bibliography: ▪ G.A. Nemneş, T.L. Mitran, A. Nicolaev, L. Ion, *Aplicații MPI pentru sisteme de calcul paralel – îndrumător de laborator* (Editura Universității din București, București, 2015). ▪ Michael J. Quinn, *Parallel Programming in C with MPI and OpenMP* (McGraw-Hill, New York, USA, 2003). ▪ W. Gropp, E. Lusk, A. Skjellum, Using MPI: portable parallel programming with the Message-Passing Interface (MIT Press, Cambridge, USA, 2014).		
8.4. Project Not Applicable	Teaching and learning techniques	Observations

Bibliography:

9. 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 the course is in line with the content of similar courses taught at universities in the country (West University of Timisoara) and abroad (University of Groningen, Netherlands, Technical University Wien, Austria, etc.), providing students with the training of skills and programming skills. parallel, skills and abilities of interest to companies and research institutes active in the development of MPI applications, including for modeling complex physical phenomena and processes.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	The correct use of the studied programming models and techniques; Capacity of exemplification; Capacity to apply the acquired knowledge to problem solving.	Written exam	60%
10.5.1. Tutorial			
10.5.2. Practical	Knowledge of parallel programming techniques and parallel computing infrastructure; Ability to exemplify;	Lab colloquium	40%
10.5.3. Project	Not applicable	Not applicable	Not applicable
10.6. Minimal requirements for passing the exam Mandatory attendance at all application activities (laboratory). Correctly solve the topics indicated to obtain a score of 5 on all topics, part of the assessment along the way. Correctly solve the subjects indicated to obtain a score of 5 in the final exam (MPI communication operations). Requirements for getting mark 10 (10 points scale) Skills, well-argued knowledge Demonstrated ability to analyze problems, solve all topics correctly			

Date 05.11.2021	Teacher’s signature Prof.dr. Lucian Ion	Practicals/Tutorials instructor’s signature Conf.dr. George Alexandru Nemneș

Date of approval 11.11.2021	Head of Department Conf.dr. Adrian Radu

DFC.202F.EN Methods for data analysis and data mining

1. Study program

1.1. University	University of Bucharest
o 1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State Physics and Biophysics
1.4. Field of study	Physics Informatics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Methods for data analysis and data mining							
2.2. Lecturer				Prof. Dr. Ana-Nicoleta Bondar				
2.3. Tutorials/Practicals instructor(s)				Prof. Dr. Ana-Nicoleta Bondar				
2.4. Year of study	2	2.5. Semester	II	2.6. Type of evaluation		2.7. Type of course unit	Content [1)]	DC
							Type [2)]	DFac

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	4	distribution:	Lectures	2	Tutorials	-	Practicals	1	Project	1
3.2. Total hours per semester	56	distribution:	Lectures	28	Tutorials	-	Practicals	14	Project	14

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	10
3.3.2. Research in library, study of electronic resources, field research	10
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	20
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	40
3.5. Total hours per semester	100
3.6. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Physics, Bachelor
4.2. competences	Classical Mechanics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for practicals/tutorials/projects	Desktop computer or personal laptop

6. Specific competences acquired

Professional competences	Working with data sets, computer programming, scientific discussion in English
Transversal competences	Scientific communication in English

7. Course objectives

7.1. General objective	Learn modern methods for data analysis and data mining in physics
7.2. Specific objectives	Hands-on experience with modern software used for data analyses in physics

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Introduction in modern methods in computational physics. Applications from quantum mechanics. Applications from classical mechanics	Presentation. Examples. Interactive discussion	2 hours
Introduction in numerical simulations. Additive force fields; cross-terms, polarization	Presentation. Examples. Interactive discussion	2 hours
Numerical simulations of liquids. Structure of data from atomistic simulations. Example 1: Simulations of aqueous solutions	Presentation. Examples. Interactive discussion	2 hours
Intrinsically disordered proteins as models of charged polymers in aqueous solution.	Presentation. Examples. Interactive discussion	2 hours
Statistical analyses of molecular dynamics data. Time correlation functions. Potential of mean force. Data clustering algorithms	Presentation. Examples. Interactive discussion	4 hours
Applications of force fields to descriptions of charged	Presentation. Examples.	4 hours

polymers in aqueous solutions	Interactive discussion	
Algorithms and methodologies to derive force fields. The Seminaris method. Potential energy scans. Normal mode matching	Presentation. Examples. Interactive discussion	2 hours
Graph theory, part 1: Introduction, Definitions	Presentation. Examples. Interactive discussion	2 hours
Graph theory, part 1: Centrality measures, transition matrices	Presentation. Examples. Interactive discussion	4 hours
Machine learning. Introduction, applications to force field development	Presentation. Examples. Interactive discussion	4 hours
Bibliography: 1. Hans Kuhn, Principles of Physical Chemistry, Wiley-Interscience 2009 2. Daniel Zuckermann, Statistical Physics of Biomolecules, Taylor & Francis 2010 3. Tildesley & Allen, Molecular Simulations of Liquids, Oxford University Press 2021		
8.2. Tutorials	Teaching and learning techniques	Observations
Introduction to Visual Molecular Dynamics	Practical computer work. Interactive discussion	1 hours
Introduction to Avogadro	Practical computer work. Interactive discussion	1 hours
Generate and visualize simple molecules – butane, water, dipeptides. Inspect geometry	Practical computer work. Interactive discussion	2 hours
Generate and visualize water box with and without salt at specific concentration	Practical computer work. Interactive discussion	2 hours
Generate and visualize intrinsically disordered peptide in water box at specific salt concentration	Practical computer work. Interactive discussion	2 hours
Analyze a molecular dynamics trajectory of aqueous solution. Compute and interpret radial distribution function.	Practical computer work. Interactive discussion	2 hours
Analyze a molecular dynamics trajectory of intrinsically disordered peptide in aqueous solution. Radius of gyration.	Practical computer work. Interactive discussion	2 hours
Compute time series, histograms, and potential of mean force for data sets from numerical simulations	Practical computer work. Interactive discussion	2 hours
Analyze vibrational modes of butane	Practical computer work. Interactive discussion	2 hours
Introduction to graphical user interfaces for graph-based analyses: Bridge and C-Graphs	Practical computer work. Interactive discussion	2 hours
Use graph-based analyses to analyze dynamics of an intrinsically disordered peptide.	Practical computer work. Interactive discussion	2 hours
Bibliography: 1. Tuturial for Visual Molecular Dynamics: https://www.ks.uiuc.edu/Training/Tutorials/vmd/tutorial-html 2. How to use Avogadro: https://avogadro.cc/docs/getting-started/drawing-molecules 3. User’s Manual for C-Graphs: Bertalan, Lesca, Schertler & Bondar, Journal of Chemical Information and Modeling 2021, doi: 10.101/acs.jcim.1c00827		
8.3. Practicals	Teaching and learning techniques	Observations
Bibliography:		
8.4. Project	Teaching and learning techniques	Observations
Write 10-page summary of practical computer work.	Individual practical computer work	8 hours
Bibliography:		

9. 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)

Knowledge of methods of data analysis and numerical physics is essential to tackle modern challenges in physics. An example of curriculum that includes numerical simulation methods for physics students is from the University of York, UK: https://www.york.ac.uk/media/physics/pdfs/2021%20Entry_%20Physics-openday-brochure.pdf

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	Ability to discuss theory concepts from the lecture	Written, followed by discussion	40%
10.5.1. Tutorial	Completion of all tasks from the tutorial.	Completion of all tasks during the semester. Ability to discuss tasks	20%
10.5.2. Practical	-	-	-
10.5.3. Project	Ability to complete individual study	Deliver summary of all practical tasks. Ability to interpret data	20%
10.6. Minimal requirements for passing the exam Minimum 50% of lecture hours must be attended. All tutorial hours and tasks are compulsory. Deliver project assignment consisting of 10 page summary of all computer work. Requirements for getting mark 10 (10 points scale) Skills, well-argued knowledge Demonstrated ability to analyze phenomena and processes			

Date 8.11.2021	Teacher's name and signature Prof. Dr. Ana-Nicoleta Bondar	Practicals/Tutorials instructor(s) name(s) and signature(s) Prof. Dr. Ana-Nicoleta Bondar

Date of approval 11.11.2021	Head of Department Conf.univ.dr. Adrian Radu

DFC.203F.EN Introduction to radioastronomy

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Introduction to radioastronomy								
2.2. Teacher				Prof. dr. Alina Badescu, dr. Valeriu Tudose					
2.3. Tutorials/Practicals instructor(s)				Prof. dr. Alina Badescu, dr. Valeriu Tudose					
2.4. Year of study	II	2.5. Semester	I	2.6. Type of evaluation	E	2.7. Type of course unit	Content 1)	DS
							Type 2)	DFc

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	2	distribution:	Lectures	1	Tutorials	-	Practicals	1	Project	-

3.2. Total hours per semester	28	distribution:	Lectures	14	Tutorials	-	Practicals	14	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	12
3.3.2. Research in library, study of electronic resources, field research	3
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	3
3.3.4. Examination	4
3.3.5. Other activities	X

3.4. Total hours of individual study	18
3.5. Total hours per semester	50
3.6. ECTS	2

4. Prerequisites (if necessary)

4.1. curriculum	-
4.2. competences	-

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Real and complex analysis; Electricity and magnetism; Electrodynamics
5.2. for practicals/tutorials/projects	General knowledge of waves, vectorial calculus, statistics

6. Specific competences acquired

Professional competences	Understanding phenomena and physical processes pertaining to radioastronomy in the context of the cosmic objects under study and the instruments used. Familiarity with the basic notions in the field which will assure a solid base for further studies in astrophysics and engineering.
Transversal competences	Methodical and objective analysis of the issues, identifying elements for which known solutions exist.

7. Course objectives

7.1. General objective	The course offers a fundamental introduction in radioastronomy and the measurement techniques employed for the detection of radiation from cosmic objects.
7.2. Specific objectives	The components and functioning of a radiotelescope will be discussed. The concept of interferometry will be presented. Elements of electromagnetic waves propagation in extraterrestrial media will be introduced. The main radio emitting cosmic objects and the associated relevant physical processes will be presented.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Radioastronomy 1.1. Introduction 1.2. Radiotelescopes 1.3. Radioastronomy and implications in science 1.4. The atmosphere. Windows for radio waves	On-line or in person	1 h
2. Fundamentals 2.1. The electromagnetic spectrum 2.2. Radiative transfer 2.2.1. Emission 2.2.2. Absorption 2.3. The radiative transfer equation		1 h
3. Propagation and properties of radio waves 3.1. Propagation in various media 3.2. Reference frames 3.3. Polarization. Stokes parameters 3.4. Faraday rotation		1.5 h
4. Detectors and signal processing		3 h

4.1. Bolometer 4.2. Radiometer 4.3. Radiotelescope 4.4. Next generation of radioastronomical detectors 4.5. Signal processing		
5. Antenas 5.1. Fundamentals 5.2. Geometry 5.3. Detection of partially polarized waves 5.4. Antenna temperature 5.5. Observing methods 5.6. Antenna calibration		1.5 h
6. Radio interferometry		1 h
7. Radio emission mechanisms 7.1. Bremsstrahlung 7.2. Non-thermal radiation. Synchrotron. 7.3. Inverse Compton scattering 7.4. Masers		2.5 h
8. Radio emitting objects 8.1. Plasma clouds 8.2. Atomic neutral hydrogen 8.3. Molecular clouds 8.4. Planets and stars 8.5. Supernovae 8.6. Radiogalaxies 8.7. Pulsars 8.8. Cosmic microwave background 8.9. Masers		2.5 h
Bibliography: 1. Badescu A. - Introducere in Radioastronomie, MatrixRom, 2011 2. Rybicki G.B., Lightman A.P. - Radiative Processes in Astrophysics, Wiley-VCH, 1991 3. Wilson T., Rohlfs K., Huettemeister S. - Tools of Radio Astronomy, Springer, 6th ed. 2014 4. Longair M.S. - High Energy Astrophysics (2 vol.), CUP, 1994 5. Wilson T., Rohlfs K., Huetemeister S. - Tools of Radio Astronomy (Problems and Solutions), Springer, 2018		
8.2. Tutorials	Teaching and learning techniques	Observations
Bibliography:		
8.3. Practicals	Teaching and learning techniques	Observations
1. The radiative transfer equation. Brightness temperature	On-line or in person.	2 h
2. Propagation of electromagnetic waves. Faraday rotation		2 h
3. Detectors. Thermal noise		2 h
4. Antennas		2 h
5. Radio emission mechanisms		2 h
6. Radio emitting objects		2 h
7. Final report		2 h
Bibliography: **1**. Badescu A. - Introducere in Radioastronomie, MatrixRom, 2011 2. Rybicki G.B., Lightman A.P. - Radiative Processes in Astrophysics, Wiley-VCH, 1991 3. Wilson T., Rohlfs K., Huettemeister S. - Tools of Radio Astronomy, Springer, 6th ed. 2014 4. Longair M.S. - High Energy Astrophysics (2 vol.), CUP, 1994 5. Wilson T., Rohlfs K., Huetemeister S. - Tools of Radio Astronomy (Problems and Solutions), Springer, 2018		
8.4. Project	Teaching and learning techniques	Observations

Bibliography:		

9. 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)

Astrophysics has evolved continuously in the last half century. It is now a multidisciplinary field encompassing atomic and high-energy physics, general relativity, electrical engineering, information technology, chemistry, telecommunications, optics, complex mathematics, material sciences, etc. The extreme distances in the Universe, the very weak signals, as well as the high volume of astrophysical data lead to the need of more advanced detectors that push the current technology to its limits. The interaction between the requirements of astrophysics and the technological advances has a significant impact in many other fields, as diverse as e.g. national security and household appliances.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	Assimilation of fundamental theoretical notionsContinuous assessment	Continuous assessment	50%
10.5.1. Tutorial	Applying theory to practice	Final raport	50 %
10.5.2. Practical			
10.5.3. Project			
10.6. Minimal requirements for passing the exam Course attendance: minimum 50 % of the time Tutorial attendance: tutorials are compulsory			

Date 4.10.2021	Teacher’s name and signature Prof. dr. Alina Badescu, dr. Valeriu Tudose	Practicals/Tutorials instructor(s) name(s) and signature(s) Prof. dr. Alina Badescu, dr. Valeriu Tudose
Date of approval 11.11.2021	Head of Department Prof.dr. Alexandru Jipa	

DFC.204F.EN Physics of deformable media

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Departmane of Structure of Matter, Physics of the Earth and Atmosphere, Astrophysics
1.4.Field of study	Physics
1.5.Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Physics of deformable media**							
2.2. Teacher				Cheche Ovidius Tiberius				
2.3. Seminars/Laboratory instructor(s)				Cheche Ovidius Tiberius				
2.4. Year of study	2	2.5. Semester	II	2.6. Type of evaluation	E	2.7. Classification of course unit	Content [1)]	DS
							Type [2)]	DF

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester) 3.1. Hours per week in	4	distribution:	Lectures	2	Seminars	2	Laboratory works		Project	

curriculum										
3.2. Total hours per semester	56	distribution:	Lectures	28	Seminars	28	Laboratory works		Project	

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	5
3.3.2. Research in library, study of electronic resources, field research	5
3.3.3. Preparation for laboratory works/seminars/projects/reports/homework	5
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	15
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Courses: Classical Mechanics, Real Analysis, Algebra, Geometry and Differential Equations, Equations of Mathematical Physics.
4.2. competencies	Processing of Physical Data and Numerical Methods

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Interactive Multimedia Board
5.2. for laboratory works/seminars/projects	Seminar Classroom

6. Specific competences acquired

Professional competencies	Ability to apply the continuum mechanics knowledge to explain the elastic properties of solid bodies. Ability to apply the mathematical knowledge in modeling the continuous media. Ability to use the specific notions of elasticity. Ability to solve textbook problems.
Transversal competencies	Efficient use of the scientific resources of physics. Efficiently and responsibly solving of professional tasks by obeying the legal laws, ethics and deontology of science, being supervised by qualified personnel.

7. Course objectives

7.1. General objective	Assimilation of knowledge in the field of elasticity, ability to solve elasticity problems.
7.2. Specific objectives	Developing the ability to infinitesimally model the elastic properties of continuous media. Learning from simple (Hooke's law) to complex (3D models for elasticity of solid bodies) by using the laws of classical mechanics and the theory of differential equations. Developing the ability to solve elasticity problems, as well as to formulate rigorous theoretical conclusions. Acquiring a deep theoretical understanding of the studied topic.

8. Contents

8.1. Lectures[chapters]	Teaching techniques	Observations
Vectors, matrices, and tensors. Second order tensors in Cartesian and curvilinear orthogonal coordinates.	Lecture. Examples.	2 hours
Strain and Stress. Displacement vector, rotation strain tensor. Change of basis for the strain tensor. Vector and stress tensor. Change of basis for the stress tensor.	Lecture. Examples.	8 hours

Stress distributions in radial compressed disk. Equilibrium equations in Cartesian, spherical,and cylindrical coordinates. Generalized Hooke's law. Fourth order tensor of compliance for an elastic solid. Young modulus, Poisson ratio.		
Types of elasticity problem as a function of boundary conditions. Stress tensor method for given forces normally applied on the body surface. Displacement method for given volume forces and displacements at the body surface.	Lecture. Examples.	3 hours
Elasticity models. Deformation energy. Euler-Bernoulli theory for an elastic beam. Rayleigh-Ritz method for the stress calculus. Models for two-dimensional elastic surfaces, stress and strain methods. Polynomial, Fourier's series, and integral method solutions. Three-dimensionale models for the elasticity properties study. Galerkin vector representation. Examples in micro-mechanics.	Lecture. Examples.	11 hours
Elastic waves. Elastic waves in isotropic continuous media and crystals. Vibrations of beams and two-dimensional surfaces.	Lecture. Examples.	4 hours

References:
1. M.H. Sadd, Elasticity Theory, Applications, and Numerics, Academic Press, 2020.
2. S.P. Timoshenko, J. M. Gere, Theory of elastic stability, McGraw-Hill International Book Company , 1964.
3. R.K. Bansal, Strength of Materials, Laxmi Publication LTD, New-Dehli, 2009.
4. L. Landau, E. Lifshitz, Theory of Elasticity, Butterworth-Heinemann; 3rd edition 1986.
5. Y.A. Amenzade. Theory of elasticity, Mir, 1979.

8.2. Seminars	Teaching and learning techniques	Observations
Vector operators (gradient, divergence, curl, Laplace) and second order tensors in polar coordinates, spherical, cylindrical.	Interacting lectures.	3 hours
Generalized Hooke's law.		2 hours
Transformation of the second order tensors by rotations.	Interacting lectures.	3 hours
Stress expression in polar coordinates, spherical, cylindrical. Stress distribution in a radially compressed disc.	Interacting lectures.	4 hours
Shear stress. Deformations and uniaxial stress in elastic cylinders.	Interacting lectures.	3 hour
Elogation, strain energy due to self weight in cylindrical bar. Torsion of a cylindrical and prismatic bar.	Interacting lectures.	3 hours
Rayleigh-Ritz method for stress calculus in elastic beam.	Interacting lectures.	3 hours
Strain-stress relation in spherical and cylindrical multi-layer nanostructures.		3 hours
Uniaxial elongation of a bar. Deflection of a beam under various types of deformating forces. In-plane deformation of a rectangular plate.	Analize critice. Exemple	3 hours
Helicoydal spring.	Analize critice. Exemple	1 hour

References:
1. M.H. Sadd, Elasticity Theory, Applications, and Numerics, Academic Press, 2020.
2. S.P. Timoshenko, J. M. Gere, Theory of elastic stability, McGraw-Hill International Book Company , 1964.
3. R.K. Bansal, Strength of Materials, Laxmi Publication LTD, New-Dehli, 2009.
4. Y.A. Amenzade. Theory of elasticity, Mir, 1979.
5. T.E. Pahomi, T.O. Cheche, Strain influence on optical absorption of giant semiconductor colloidal quantum dots, *Chemical Physics Letters* **612**, 33-38 (2014).

6. ”Optical Excitations of Colloidal Core-Shell Semiconductor Quantum Dots”, autor: T.O. Cheche, in cartea: *Colloids*, ISBN 978-953-51-4919-4, Book edited by: Dr. Mohammed Muzibur Rahman, InTech, 2016. pagini: 155-174.		
8.3. Laboratory works	Teaching and learning techniques	Observations
References:		
8.4. Project	Teaching and learning techniques	Observations
References:		

9. 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 the present teaching plan, which is in accordance with similar content provided at other national (Universitatea Babeş-Bolyai, Cluj Napoca, Universitatea „Alexandru Ioan Cuza” din Iași) and international universities (University of Groningen, Netherlands, Warwick University, UK, University of Tubingen, Germany, Technical University Wien, Austria, etc.), ensures formation of the skills useful to analyze physical phenomena specific to the continuous media, identify applications, capacities, and abilities of interest for companies and research institutes involved in the mechanics research.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	Clarity, coherence, and conciseness of presentation; Correct use of the physical models, mathematical equations, and algebra; Capacity to exemplify; Capacity of applying the knowledge to clearly formulate hypotheses for various mechanics problems of elasticity.	Exam-written test	70%
10.5.1. Seminar	Ability to solve textbook problems of elasticity.	Homework check	30%
10.5.2. Laboratory work			
10.5.3. Project			

Date
01.11.2021

Teacher’s name and signatu
Conf. dr. Tiberius Ovidius Cheche

Laboratory/Seminar instructor(s) name(s) and signature(s
Conf. dr. Tiberius Ovidius Cheche

Date of approval
11.11.2021

Head of Department
Prof.dr. Alexandru Jipa

DFC.301F.EN Astrophysics and planetology

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Astrophysics and planetology								
2.2. Teacher				Prof. dr. Octavian Duliu					
2.3. Tutorials/Practicals instructor(s)				Prof. dr. Octavian Duliu					
2.4. Year of study	III	2.5. Semester	I	2.6. Type of evaluation	C	2.7. Type of course unit	Content 1)	DC	
							Type 2)	DFc	

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	2	Tutorials	-	Practicals	1	Project	-
3.2. Total hours per semester	42	distribution:	Lectures	28	Tutorials	-	Practicals	14	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one’s own course notes, manuals, lecture notes, bibliography	15
3.3.2. Research in library, study of electronic resources, field research	5
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	9
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	29
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Mechanics, Thermodynamics, Electrodynamics, Atomic and Molecular Physics, Optics, Spectroscopy,
4.2. competences	Use of software packages for data analysis and processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Room with multimedia equipment (video projector)
5.2. for practicals/tutorials/projects	Room with multimedia equipment (video projector) + laboratory works

6. Specific competences acquired

Professional competences	1) Identify and properly use the main laws and principles of physics in a given context; identifying and using notions and laws for the comic space 2) Solving physics problems under imposed conditions 3) Creative application of the acquired knowledge in order to understand and model the processes and physical properties of the systems 4) Communication and analysis of information of a didactic, scientific and popularization nature in the field of physics 5) Use / development of specific software tools
Transversal competences	1) Efficient use of information sources and communication and training resources 2) Carrying out professional tasks efficiently and responsibly in compliance with the legislation, ethics and deontology specific to the field.

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7. 0...2Course objectives

7.1. General objective	The presentation of the Solar System, its formation and dynamics discussed on the basis of Newtonian theory, the formation of planets, their geological composition and methods of investigation, their geological composition and methods of their investment.
7.2. Specific objectives	Use knowledge of mechanics, thermodynamics, electromagnetism and atomic and nuclear physics to understand the Solar System. Addressing some fundamental problems necessary to understand the phenomena that allow the student to form a way of thinking, developing and creatively solving physics problems.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Solar system. Composition. Planets and satellites. Comets, asteroids and cosmic dust. Genesis of the solar system. The formation of the earth, the age of the oldest rocks. Newtonian dynamics of the solar system.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 h
Our galaxy (the Milky Way). Composition, structure. Dynamics of the galaxy. Types of galaxies. Training and characterization.	Systematic exposition - lecture. Examples	2 h
The evolution of dynamic systems. Planetary dynamics. Stability and instability in multi-body systems. Ex. Saturn's rings.	Systematic exposition - lecture. Heuristic conversation. Examples	4 h
The Origin of Elements in the Universe - Mendeleev's Table and Natural Elements		4 h
Light in astronomy; light-cosmic dust interaction processes (scattering; polarization, absorption, fluorescence, ef. Auger, ..). Radio broadcast, Radio astronomy. Radiative processes in astrophysics; emission and absorption; braking radiation (cyclotronic, synchrotronic); acceleration of particles in outer space;	Systematic exposition - lecture. Heuristic conversation.. Critical analysis. Examples	4 h
Stable isotopes of paleontological and geological importance: carbon isotopes (mantle, igneous rocks, diamonds, organic matter, marine minerals, ...), stable isotopes of sulfur, stable isotopes of nitrogen, stable isotopes of chlorine and bromine; natural and artificial radioactivity; radioactive series; kinetics of isotopic chemistry; chemical, isotopic reactions, equilibria, isotopic separations.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	2 h
K-Ar and 40Ar / 39Ar dating method; Dating method Rb-Sr, Sm-Nd, Lu-Hf, Re-Os. Sr and Nd geochemistry in meteorites, terrestrial magmatites and sedimentary rocks. U-Pb, Th-Pb dating method. Isotope geochemistry Pb.	Systematic exposition - lecture. Examples	2 h
The U unbalanced series. 210Pb dating. Dating with 14C of cosmogenic origin. He and Tritium: U-Th / He and Tritium-3He. Cosmogenic radionuclides: 10Be, 26Al.	Systematic exposition - lecture. Heuristic conversation. Examples	2 h
Apparatus and methods used in isotope applications: Mass spectrometer, measured masses, calculated masses. Thermoluminescence dating; cathodoluminescence; Paleomagnetism; Theories of the origin of the magnetic fields of the planets. Current applications of electronic paramagnetic resonance:	Systematic exposition - lecture. Examples	4 h

Bibliography:
A. Carrington, A.D.McLachlan, Introduction to magnetic resonance with applicayion to chemistry and chemical physics, Harper & Row, 1967
J.R. Bolton, J.A.Weil, Electron paramagnetic resonance : elementary theory and practical aplications, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007
C.P. Slichter, Principle of magnetic resonance, Springer Verlag Berlin Heidelberg GmbH, 1978
A. Abragam, B. Bleaney, Electron Paramagnetic Resonance of Transition Ions, Oxford University Press, 1970
M. Ikeya, New applications of electron spin resonance: Dating, Dosimetry and Microscopy, World Scientific, 1993
A. Schweiger, G. Jeschke, Principles of Pulse Electron Paramagnetic Resonance, Oxford University Press, 2001
C.D. Negut,M. Cutrubinis, ESR Standard Methods for Detection of Irradiated Food, în: A. K. Shukla (ed.) Electron Spin Resonance in Food Science, Elsevier, Academic Press (2017)
O.G. Duliu, V. Bercu, ESR Investigation of the Free Radicals in Irradiated Foods, în: A. K. Shukla (ed.) Electron Spin Resonance in Food Science, Elsevier, Academic Press (2017)
O.G. Duliu, V. Bercu, D. Neguț, Mn^{2+} EPR spectroscopy for the provenance study of natural carbonates, în: A. K. Shukla (ed.) Electron Magnetic Resonance - Applications in Physical Sciences and Biology, Elsevier, Academic Press (2019)
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8.3. Practicals	Teaching and learning techniques	Observations
Conditiile paleoclimatice din timpul Cretacicului superior (cu exemplificare din Bazinul Hateg)	Guided practical activities	2 h
Calculation of absolute ages based on radiogenic isotopes	Guided practical activities	2 h
Calculation of temperature based on the composition of stable isotopes The formation of the earth, the age of the oldest rocks	Guided practical activities	2 h
K-Ar and 40Ar / 39Ar dating method.	Guided practical activities	2 h
U-Pb, Th-Pb dating method. Isotope geochemistry Pb. U. Unbalanced series. 210Pb dating.	Guided practical activities	2 h
Interstellar matter; cosmology; isotopy in astrophysics - the two images of the supernova explosion. Spectrum analysis.	Guided practical activities	2 h
Histria statuette - use of the X-ray attenuation coefficient Oklo natural reactor - Gabon - isotopic identification	Guided practical activities	2 h

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8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 identify the contents and choose the teaching / learning methods, the holders of the subject consulted the content of similar disciplines taught at universities in the country and abroad such as Swiss Federal Institute of Technology in Zurich (ETH Zurich), University of Padua, University of Southern California. The content of the discipline is in accordance with the requirements for employment in research institutes in physics and education.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Clarity, coherence and conciseness of the presentation; - Correct use of calculation models,	Test	50%

	formulas and relationships; - Ability to exemplify;		
10.5.1. Tutorial			
10.5.2. Practical	- Individual activity - Knowledge and use of experimental techniques; - Interpretation of results;	Test	50 %
10.5.3. Project			
10.6. Minimal requirements for passing the exam Course attendance: minimum 50 % of the time Tutorial attendance: tutorials are compulsory			

Date 15.10.2021	Teacher's name and signature Prof. dr. Octavian Duliu	Practicals/Tutorials instructor(s) name(s) and signature(s) Prof. dr. Octavian Duliu

Date of approval 11.11.2021	Head of Department Prof.dr. Alexandru Jipa

DFC.302F.EN Experimental methods in astrophysics and planetology

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Astrophysics and planetology							
2.2. Teacher				Prof. dr. Octavian Duliu				
2.3. Tutorials/Practicals instructor(s)				Prof. dr. Octavian Duliu				
2.4. Year of study	III	2.5. Semester	I	2.6. Type of evaluation	C	2.7. Type of course unit	Content [1]	DC
							Type [2]	DFc

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	2	Tutorials	-	Practicals	1	Project	-
3.2. Total hours per semester	42	distribution:	Lectures	28	Tutorials	-	Practicals	14	Project	-

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	15
3.3.2. Research in library, study of electronic resources, field research	5
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	9
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	29
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Mechanics, Thermodynamics, Electrodynamics, Atomic and Molecular Physics, Optics,

	Spectroscopy, Mathematical Analysis
4.2. competences	Use of software packages for data analysis and processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Room with multimedia equipment (video projector)
5.2. for practicals/tutorials/projects	Room with multimedia equipment (video projector) + laboratory works

6. Specific competences acquired

Professional competences	1) Identify and properly use the main laws and principles of physics in a given context; identifying and using notions and laws for the comic space 2) Solving physics problems under imposed conditions 3) Creative application of the acquired knowledge in order to understand and model the processes and physical properties of the systems 4) Communication and analysis of information of a didactic, scientific and popularization nature in the field of physics 5) Use / development of specific software tools
Transversal competences	1) Efficient use of information sources and communication and training resources 2) Carrying out professional tasks efficiently and responsibly in compliance with the legislation, ethics and deontology specific to the field.

7. Course objectives

7.1. General objective	The presentation of the Solar System, its formation and dynamics discussed on the basis of Newtonian theory, the formation of planets, their geological composition and methods of investigation, their geological composition and methods of their investment.
7.2. Specific objectives	Use knowledge of mechanics, thermodynamics, electromagnetism and atomic and nuclear physics to understand the Solar System. Addressing some fundamental problems necessary to understand the phenomena that allow the student to form a way of thinking, developing and creatively solving physics problems.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
1. Isotopic analysis. Radiochemistry. Radioactive gases (Radon)	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	3 h
2. Mass spectrometry. Visible spectrometry, IR and UV. Elemental and rock analysis. Thermoluminescence. X - ray (fluorescence) and gamma spectrometry.	Systematic exposition - lecture. Examples	4 h
3. Magnetic resonance imaging methods (MRI, RES, Mössbauer)	Systematic exposition - lecture. Heuristic conversation. Examples	3 h
4. Astronomy in visible, IR, UV. Telescopes, telescopes and radiation detectors	Systematic exposition - lecture. Heuristic conversation. Examples	3 h
5. Radio broadcasting, Radio astronomy. Radiative processes in astrophysics; emission and absorption; braking radiation (cyclotronic, synchrotronic); Radio telescopes, Compton Telescope, Radiotelescope networks, Auger Observatory, Underground laboratories - neutrino detection.	Systematic exposition - lecture. Heuristic conversation.. Critical analysis. Examples	3 h
6. Paleomagnetism; Theories of the origin of the magnetic fields of the planets. Terrestrial magnetometry. The Sun's magnetic field.	Systematic exposition - lecture. Heuristic conversation. Critical analysis. Examples	4 h
7. The Zeeman effect and the Kerr effect.	Systematic exposition - lecture. Examples	2 h
8. Crystallography and crystal physics. Color centers.	Systematic exposition - lecture. Heuristic conversation. Examples	2 h

9. Astrophotography. Color control. Analog filters and digital filter. Image processing programs. Remote sensing.	Systematic exposition - lecture. Examples	2 h
10. Calculation and data processing methods. Graphics, time series analysis, data fit, errors and confidence limits	Systematic exposition - lecture. Examples	2 h

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8.3. Practicals	Teaching and learning techniques	Observations
1. Methods in radiochemistry	Guided practical activities	2 h
2. Calculation of radioactive series. U-series imbalances. Examples	Guided practical activities	2 h

8. Time series analysis.	Guided practical activities	2 h
4. X-ray attenuation in compounds and rocks. Use of the X-ray attenuation coefficient.	Guided practical activities	2 h
5. Crystallization systems. Crystallographic analysis. Crystals and rocks. Examples	Guided practical activities	2 h
6. Analysis of electromagnetic radiation spectra in galactic space and interplanetary space. The role of cosmic dust. Examples	Guided practical activities	2 h
7. Experimental data processing. Astrophotography. Imaging.	Guided practical activities	2 h

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A. Lund, M. Shiotani (eds.) Applications of EPR in Radiation Research, Springer, 2014

8.4. Project	Teaching and learning techniques	Observations
Bibliography:		

9. 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 identify the contents and choose the teaching / learning methods, the holders of the subject consulted the content of similar disciplines taught at universities in the country and abroad such as Swiss Federal Institute of Technology in Zurich (ETH Zurich), University of Padua, University of Southern California. The content of the discipline is in accordance with the requirements for employment in research institutes in physics and education.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Clarity, coherence and conciseness of the presentation; - Correct use of calculation models, formulas and relationships; - Ability to exemplify;	Test	50%
10.5.1. Tutorial			
10.5.2. Practical	- Individual activity - Knowledge and use of experimental techniques; - Interpretation of results;	Test	50 %
10.5.3. Project			
10.6. Minimal requirements for passing the exam Course attendance: minimum 50 % of the time Tutorial attendance: tutorials are compulsory			

Date 15.10.2021	Teacher’s name and signature Prof. dr. Octavian Duliu	Practicals/Tutorials instructor(s) name(s) and signature(s) Prof. dr. Octavian Duliu

Date of approval 11.11.2021	Head of Department Prof.dr. Alexandru Jipa

DFC.303F.EN Unconventional methods for energy production

1. Study program

1.1. University	University of Bucharest
o 1.2. Faculty	Faculty of Physics
1.3. Department	The Structure of Matter, the Physics of the Atmosphere and the Earth, Astrophysics
1.4. Field of study	Physics
1.5. Course of study	Undergraduate/Bachelor of Science
1.6. Study program	Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	Unconventional methods for energy production							
2.2. Teacher			Lecturer PhD Sanda Voinea					
2.3. Tutorials/Practicals instructor(s)								
2.4. Year of study	3	2.5. Semester	1	2.6. Type of	C	2.7. Type of	Content [1)]	DC

				evaluation		course unit	Type 2)	Dfac

1) fundamental (DF), speciality (DS), complementary (DC); 2) compulsory (DI), elective (DO), optional (Dfac)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	3	distribution:	Lectures	2	Tutorials	0	Practicals	1	Project	0
3.2. Total hours per semester	42	distribution:	Lectures	28	Tutorials	0	Practicals	14	Project	0

3.3 Distribution of estimated time for study	hours
3.3.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	8
3.3.2. Research in library, study of electronic resources, field research	9
3.3.3. Preparation for practicals/tutorials/projects/reports/homeworks	12
3.3.4. Examination	4
3.3.5. Other activities	

3.4. Total hours of individual study	29
3.5. Total hours per semester	75
3.6. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Notions of mathematics, physics, chemistry intermediate level
4.2. competences	Knowledge of the use of graphic representation programs.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia room (video projector)
5.2. for practicals/tutorials/projects	Laboratory with modern equipment that allows experiments to be performed;

6. Specific competences acquired

Professional competences	• Acquiring and understanding the theoretical concepts linked to the physical and electrochemical phenomena that cause the conversion of unconventional energy from various renewable sources. • Learning the specific terminology used by the discipline; • Developing the ability to connect the results of the field with other fundamental disciplines (electricity, electronics, polymer physics, chemistry, biology); • Ability to use the notions in the field in specific situations of practical interest; • Development of experimenter skills; Development of information management skills (ability to collect and analyze information from various sources including the use of software packages for data analysis and processing)
Transversal competences	• Cultivating the concern for professional development by training the skills of abstraction and those of experimental testing of scientific theories; • Developing the tendency to get involved in scientific activities (elaboration of articles and specialized studies) and in the design of laboratory experiments. • Developing the ability to adapt and respond quickly to new situations. Concern for the achievement of the work done

7. Course objectives

7.1. General objective	• Assimilation of theoretical and experimental foundations associated with unconventional energy sources and their specific parameters. Understanding the theoretical and practical principles of construction and use of fuel cells, wind turbines, geothermal power plants, solar power plants.
7.2. Specific objectives	- Understanding the fundamental concepts and models in the field; - Learning scientific methods of analysis; - Description and understanding of the phenomenon of energy conversion that takes place in different devices; -Knowledge of the operating principles of wind, geothermal and solar power plants. - Development of the ability to quantitatively analyze specific cases - Development of experimental skills and mastering the principles of operation of energy converters.

8. Contents

8.1. Lectures [chapters]	Teaching techniques	Observations
Alternative and renewable types of energy. Environmental impact.	Lecture. Example. Discussion.	4 hours
Types of fuel cells. Fuel cell components.	Lecture. Example. Discussion.	4 hours
Principles of fuel cell operation. Electrocatalysts. Ion conducting membranes.	Lecture. Example. Discussion.	4 hours
Green hydrogen. Production and storage.	Lecture. Example. Discussion.	4 hours
Wind energy. Types of wind turbines.	Lecture. Example. Discussion.	4 hours
Geothermal energy. Geothermal power plants.	Lecture. Example. Discussion.	4 hours

Bibliografie:

Bibliografie:
Jürgen Garche, Chris K. Dyer Encyclopedia of electrochemical power sources, Elsevier 2009
Kirt A. Page, Christopher L. Soles, James Runt, Polymers for Energy Storage and Delivery: Polyelectrolytes for Batteries and Fuel Cells
F. Barbir PEM Fuel Cells theory and practice, Elsevier 2005
Electrochimical methods: Fundamentals and Applications, Allen J. Bard, ISBN:978-0-12078-142-3, Elsevier
Wolf_Vielstich_Hubert_A._Gasteiger, Handbook Fuel Cells set 7 vol, Willey 2009
University of Cambridge. http://www.doitpoms.ac.uk/miclib/index.php
Fundamentals of materials for Energy and Enviromental Sustainaiblity D.S. Ginley and David Cahen
Sustainable energy Jefferson W.Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, William A. Peters, MIT Press, 2005
Renewable energy, Third Edition, Sorensen, 2005
Notițe de curs, Sanda Voinea, Adriana Bălan, pdf.

8.2. Tutorials	Teaching and learning techniques	Observations

Bibliography:

8.3. Practicals	Teaching and learning techniques	Observations
Electrolysis. The laws of electrolysis.	Guided practical activity	4 hours
Characteristic curve of the electrolyzer. Hydrogen production. Hydrogen storage in metal hydrides.	Guided practical activity	4 hours
Characteristic curve of the H2 / O2 fuel cell. Energy efficiency of the H2 / O2 fuel cell. Mg fuel cell.	Guided practical activity	4 hours
Wind turbine. Laboratory testing.	Guided practical activity	2 hours
Solar and solar thermal panels. Laboratory testing	Guided practical activity	4 hours

Bibliography:

Laboratory work. Renewable and alternative energy sources. Ioan Stamatin, Sanda Voinea

8.4. Project	Teaching and learning techniques	Observations

Bibliography:

9. 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 discipline responds to the current requirements of development and evolution at national and international level of higher education in the field of physics and energy sources.
• The subject curriculum is adapted to the current level of knowledge and requirements of scientific research and technological activities, being correlated with similar study programs from European universities applying the Bologna

system. The holders of the subject consulted the content of similar disciplines taught at universities in the country and abroad (Princeton University - Chemistry Dep, Denmark Technical University - Department of Energy Conversion and Storage, Trinity College Dublin - School of Chemistry, Reykjavik University / Iceland School of Energy). The content of the discipline is in accordance with the requirements for employment in research institutes in physics and materials science and in education (in accordance with the law). • In the current context of technological development, the targeted fields of activity are practically unlimited, the possible employers being both from the educational environment and from the industrial and research-development environment.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- Ability to understand and present correctly the main experimental and theoretical results; - The ability to argue scientifically, the ability to support mathematically the main results; - Ability to relevantly exemplify the ideas presented; - Ability to extract significant practical consequences from theoretical results; - Ability to use theoretical knowledge in solving test problems -solving homework	Colloquium - presentation of a project based on a course topic proposed by the teacher Individual / group homework	50% 20%
10.5.1. Tutorial			
10.5.2. Practical	Ability to describe and perform laboratory experiments; - Ability to use specific laboratory equipment; - Participation without exception in all laboratory meetings; - Interpretation of results and timely processing of experimental data, materialized in the presentation of laboratory reports.	• -Laboratory Colloquium-Evaluation of reports prepared in the laboratory, correct data processing and drawing their own conclusions	30%
10.5.3. Project			
10.6. Minimal requirements for passing the exam Completion of all laboratory work and grade 5 at the colloquium Homework solving. Completion of a project according to the topic proposed by the teacher to obtain the score 5.			

Date 10.11.2021	Teacher’s name and signature Lecturer Sanda Voinea	Practicals/Tutorials instructor(s) name(s) and signature(s) Adriana Balan
Date of approval 11.11.2021	Head of Department Professor PhD Alexandru Jipa	