SYLLABUS

1. Information about the study programme

1.1 Institution of higher education	WEST UNIVERSITY OF TIMISOARA
1.2 Faculty	PHYSICS AND MATHEMATICS
1.3 Department of	PHYSICS
1.4 Field of study	PHYSICS
1.5 Study cycle	MASTER
1.6 Study programme	ADVANCED RESERCH METHODS IN PHYSICS / according to COR: Analyst - 251201; Research assistant in physics - 211103; Physicist - 211101; Teacher - 233002;

2. Information about the subject/discipline

2.1 Name			Complements of solid-state physics				
2.2 Course coordinator			Prof. dr. Marius Paulescu				
2.3 Seminar coordinator			Prof. dr. Marius Paulescu				
2.4 Year of study	1	**2.5 Semester**	1	**2.6 Type of assessment**	E[1]	**2.7 Type of discipline**	DOB

3. Total estimated time (hours of teaching per semester)[2]

3.1 Number of hours per week	**3**	**3.2 course**	**2**	**3.3 seminar/laboratory**	**1**
3.4 Total hours in the curriculum	**42**	**3.5 course**	**28**	**3.6 seminar/laboratory**	**14**
Distribution of time:					**hours**
Study based on Instructions, course materials, bibliography and notes					42
Additional documentation library, specialized electronic platforms / field					35
Training seminars / laboratories, homework, essays, portfolios and essays					56
Tutoring					
Examinations[3]					**4**
Other activities					

3.7 Total hours of individual study	**133**
3.8 Total hours per semester[4]	**179**
3.9 Number of credits	**7**

[1] According to article 37, paragraph (1) of the Higher Education Law no. 199/2023, with subsequent amendments and additions, "the academic success of a student during a study program is determined by verifying the acquisition of the expected learning outcomes through exam-type evaluations and evaluation throughout the semester".

[2] The total number of contact hours and individual study hours will be aligned with the number of credits allocated to the course. One credit corresponds to a total between 25 and 30 hours of teaching activities and individual study. At the level of academic departments may establish, by discipline categories, the exact equivalence between one credit and the number of hours.

[3] The hours corresponding to examinations are added only to the point 3.8 – The total hours per semester, not to be added to the point 3.7 – Total hours of individual study.

[4] Total hours per semester = total hours in the curriculum + total hours of individual study + hours allocated to examinations.

4. Prerequisites (where applicable)

4.1 of curriculum	Not applicable
4.2 of skills	Basic knowledge in solid state physics Basic knowledge about the numerical methods applied in physics

5. Conditions (where applicable)

5.1 for the course	• Not applicable
5.2 for the seminar	• Not applicable

6. Discipline objectives - expected learning outcomes which contribute to the completion and passing the discipline

Knowledge	Acquiring knowledge in two chapters of solid state physics: semiconductor physics and crystalline nanostructures physics. Understanding the physical mechanisms that differentiate the properties of the crystalline materials from the properties of the crystalline nanostructures Knowledge about specific models for: energy bands, effective mass, nanostructured heterostructures (superlattice, quantum wires and dots), the binding energy of impurity states, density of states and conductance. Knowledge in using quantum mechanics for studying the nanostructured systems. Knowledge in using numerical methods for solving problems in solid state physics.
Skills	Modelling some physical properties of solids with a focus on semiconductors and nanocrystals. Acquiring skills in solving problems in solid state physics by using mathematical, analytical and numerical tools
Responsibility and autonomy	Carrying out professional tasks efficiently and responsibly under qualified assistance. Teamwork techniques Effective use of information sources, both in Romanian and in an international language. Acquiring a positive and responsible attitude towards one's own professional development

7. Contents

The platform through which the course materials in electronic format and other learning/bibliographic resources can be accessed: e-learning UVT.

7.1 Course	**Teaching methods**	**Comments**
1. Semiconductors: crystals, alloys, heterostructures and nanostructures	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform

2. Energy band theory. An elementary introduction to the energy band modeling	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
3. Electrons and holes. Effective mass	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
4. The Schrödinger equation with position-dependent effective mass	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
5. Numerically solving the Schrodinger equation. The transfer matrix method	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
6. Superlattices	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening..	Lecture notes available online on E-learning Platform
7. Quantum wires	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
8. Quantum dots. Artificial semiconductors	Interactive lecture, heuristic discussion, exemplification, use of	Lecture notes available online on E-learning Platform

	analogies, and discussion for knowledge consolidation and deepening.	
9. Impurities in semiconductors	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
10. Density of states in semiconductors and nanostructures	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
11. Carrier concentration in semiconductors and nanostructures	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
12. The continuity equation.	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
13. Conductance quantization. The Landauer formula	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge consolidation and deepening.	Lecture notes available online on E-learning Platform
14. Quantum conductance. Ohm's law	Interactive lecture, heuristic discussion, exemplification, use of analogies, and discussion for knowledge	Lecture notes available online on E-learning Platform

	consolidation and deepening.	

Bibliography:

1. Paulescu M. Complemente de fizica starii solide. Suport de curs accesibil pe platforma e-learning
2. C. Kittel, Introducere în fizica corpului solid. Ed. Tehnică, București, 1972.
3. S. Simon, The Oxford Solid State Physics, Oxford University Press, 2013.
4. Aguilar PZ (Ed) Nanomaterials for Medical Applications, Elsevier, 2013.
5. Harrison P. Quantum wells, wires and dots. Wiley-Interscience, 2006.
6. Sze SM, Ng KK. Physics of Semiconductor Devices, 3rd Edition, Wiley, 2006.

7.2. Seminar	**Teaching methods**	**Comments**
1. Solved problems	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
2. Illustration of band structure calculations. Problem solving.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
3. Calculating the effective mass of electrons and holes. Problem solving	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation..	Seminar support and solved problems are available online on E-learning Platform
4. Calculation of the energy states. Problem solving	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
5. Illustration of energy-state calculations in finite periodic systems.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
6. Superlattice. Problem solving:	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development.	Seminar support and solved problems are available online

	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation..	on E-learning Platform
7. Quantum wires. Problem solving.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation..	Seminar support and solved problems are available online on E-learning Platform
8. Quantum dots. Artificial semiconductors.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
9. Calculation of the binding energy of impurity states. Problem solving.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
10. Calculation of the density of states. Problem solving.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
11. Carrier concentration in semiconductors and nanostructures. Problem solving.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
12. Elements of numerical modeling of heterostructure semiconductor devices. Example.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform

13. Applications of the Landauer formula. Problem solving.	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform
14. Quantum conductance. Problem solving	Assisted problem solving and simulation. Problem formulation, solution, and algorithm development. Continuous assessment and homework evaluation.	Seminar support and solved problems are available online on E-learning Platform

Bibliography:

1. Paulescu M. Complemente de fizica starii solide. Suport de seminar accesibil pe platforma e-learning UVT.
2. C. Kittel, Introducere în fizica corpului solid. Ed. Tehnică, București, 1972.
3. S. Simon, The Oxford Solid State Physics, Oxford University Press, 2013.
4. Aguilar PZ (Ed) Nanomaterials for Medical Applications, Elsevier, 2013.
5. Harrison P. Quantum wells, wires and dots. Wiley-Interscience, 2006.
6. L. Mihaly, M.C. Martin, Solid state physics problems and solutions, Wiley, 1996.

8. Corroboration of the course contents with the epistemic expectations of the community representative, professional associations and representative employers of the programme itself

The course Complements of Solid State Physics Complement is a general physics course of which content has the role of standardizing and consolidating students' knowledge in the field of solid state physics. The focus on the physics of nanostructures is of interest for employers both from research and industry.

9. Use of tools based on generative artificial intelligence

The use of generative AI tools is not permitted during seminars or the written examination. Students may use generative AI tools when preparing for the examination and completing assignments for information retrieval, guidance, text editing, and code generation.

The most well-known examples of generative AII tools include, but are not limited to: ChatGPT, Google Gemini, Copilot for text, or MidJourney for images.
Each student will specify, in a statement written separately for each assignment, according to the model in Annex 3 of the Regulation on the use of generative artificial intelligence in the educational process at UVT, the tool they used, how it was used, and the part of the assignment in which it was used. The statement will be included by the student at the beginning of the submitted assignment.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final mark

10.4 Course	The basic theoretical knowledge and the ability to solve problems will be evaluated	Final exam. Written test consisting of questions and problems.	70 %
10.5 Seminar	The student solves the problems from the seminar and homework.	Ongoing test	30 %
10.6 Minimum performance standards			
General knowledge in energy band theory and nanostructures (quantum wells, wires and dots). The student proves the ability to solve problems like the ones studied at seminar. The student solves the problems from the seminar and the homework.			

Date of submission: 15.09.2026

Titular of the course:
Prof. Dr. Marius Paulescu
Signature:

[redacted]

Date of approval in department:

HEAD OF THE DEPARTMENT: