COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Micro and Nanoelectronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Proiect de cercetare-dezvoltare Research-developing project			
2.2 Course Lecturer				Colaborator Dr. Anca-Ionela Istrate			
2.3 Instructor for practical activities				Colaborator Dr. Anca-Ionela Istrate			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M2.O.05-11		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	2	Out of which: 3.2 course	0.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	0	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					27
Tutoring					0
Examinations					20
Other activities (if any):					0

3.7 Total hours of individual study	47.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Not applicable
4.2 Results of learning	Not applicable

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Not applicable
5.2 Seminary/ Laboratory/Project	The project will take place in a specific room, which must include: computers, Internet connection, SPICE electronic circuit simulator or MSTeams platform, etc, students with computers with a SPICE simulator installed.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

acquiring knowledge regarding the definition, obtaining and characterization of nanostructured oxide materials (thin films) using innovative technologies and advanced methods of investigation. The objective will be achieved by:

- Theoretical considerations of nanostructured materials;

- Presentation of technologies for obtaining nanostructured materials;

- Familiarization with the operation of the deposit facilities;

- Characterization of morphological, structural, optical and electrical properties;

- Interpretation of results;

- Identification of potential applications in optoelectronics, transparent electronics, solar cells, sensors.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	C1s. Use of fundamental elements relating to electronic devices, circuits, systems, instrumentation and technology C2's. Design, simulation and testing of devices, integrated circuits and micro and nanoelectronic systems with modern software tools C3's. Modeling and processing of integrated devices and circuits using advanced technologies C4's. Design, simulation and testing of optoelectronic devices, circuits and systems with modern micro and nanoelectronic software tools and technologies
Transversal (General) Competences	List the most important stages that marked the development of the field. Defines domain-specific notions. Describe/classify notions/processes/phenomena/structures. Highlight consequences and relationships.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* List the most important stages that marked the development of the field. Defines domain-specific notions. Describe/classify notions/processes/phenomena/structures. Highlight consequences and relationships.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* Selects and groups relevant information about the types of nanostructures on zinc oxide. Arguably uses specific principles in order to preserve or neglect some model parameters. Work productively in a team to carry out the project. Elaborates a scientific text in the drafting of the project Experimentally check the design solutions within the project. Solves practical applications within the project, analyzing datasets and using them within the project. Adequately interprets causal relationships between extracted values. Analyzes and compares calculated and projected values. Identifies solutions and elaborates the discipline project. Make conclusions . Arguments the solutions identified in the project .
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* elect appropriate bibliographic sources and analyze them. Respect the principles of academic ethics, correctly quoting the used bibliographic sources. Demonstrate responsiveness for new learning contexts. Demonstrates collaboration with other colleagues and teachers in carrying out teaching activities Demonstrate autonomy in organizing the learning situation/context or problem-solving situation Demonstrates social responsibility through active involvement in student social life/involvement in events in the academic community Promotes/contributes through new solutions, related to the specialty field to improve the quality of social life. Awareness of the value of its contribution in the field of engineering in identifying viable/sustainable solutions that solve problems in social and economic life (social responsibility). Apply principles of professional ethics/deontology in analyzing the technological impact of proposed solutions in the field of environmental expertise. Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialized field. Demonstrate real-life situation management skills (collaboration time management vs. conflict)

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Building on the analysis of students' learning characteristics and their specific needs, the teaching process will explore teaching methods both expository (lecture, exposure) and conversational-interactive, based on discovery learning models facilitated by direct and indirect exploration of reality (experiment, demonstration), but also on action-based methods such as exercise, practical activities and problem solving.

Lectures will be used in the teaching activity, based on PowerPoint presentations or different Internet pages that will be made available to students. Each course will start with the recapitulation of the chapters already covered, with an emphasis on the notions taken at the last course.

The presentations use images and schemes so that the information presented is easily understood and assimilated.

This discipline covers information and practical activities designed to support students in their learning efforts and to develop optimal relationships of collaboration and communication in a climate conducive to learning through discovery.

The practice of active listening and assertive communication skills, as well as feedback building mechanisms, will be considered, as ways of behavioral regulation in various situations and of adapting the pedagogical approach to the learning needs of the students.

The ability to work in teams to solve different learning tasks will be practiced.

The attention of the students will be checked by rapid tests (quizz) during or at the end of the course.

10. Contents

PROJECT		
Crt. no.	**Content**	**No. hours**
1	Considerations on obtaining nanostructured materials using advanced technologies.	8
2	Investigating the morphological properties of the obtained nanostructured materials.	4
3	Investigation of structural properties of nanostructured materials obtained.	2
4	Study of optical properties of nanostructured materials obtained.	2
5	Study of electrical properties of nanostructured materials obtained.	2
6	Interpretation and correlation of the obtained results.	8
7	Final colloquium	2
	Total:	28

Bibliography:
1. Istrate Anca https://curs.upb.ro/2021/enrol/index.php?id=9357
2. Louiza Arab, Abdelhak Amri, Afek Meftah, Aya Latif, Toufik Tibermacine, Nouraddine Sengouga, Effect of the annealing process on the properties of ZnO thin films prepared by the sol-gel method, Chemical Physics Impact, Vol. 7, 2023, 100266, ISSN 2667-0224.
3. William Vallejo, Alvaro Cantillo, Carlos Díaz-Uribe, Improvement of the photocatalytic activity of ZnO thin films doped with manganese, Heliyon, vol. 9, Issue 10, 2023, e20809, ISSN 2405-8440.
4. Zhenfeng Li, Zihan Li, Zhiyuan Shi, Pengyu Zhu, Zixu Wang, Jia Zhang, Yang Li, Peng He, Shuye Zhang, ALD prepared silver nanowire/ZnO thin film for ultraviolet detectors, Materials Today Communications, vol. 37, 2023, 106974, ISSN 2352-4928.
5. S. Uday Balegar, N. Srinatha, R. Shashidhar, A Raghu, Annealing temperature-dependent structural and optical characteristics of spray pyrolyzed ZnO thin films, Materials Today: Proceedings, vol. 92, Part 2, 2023, 1453-1458, ISSN 2214-7853.
6. Yempati Nagarjuna, Yu-Jen Hsiao, TeO2 doped ZnO nanostructure for the enhanced NO2 gas sensing on MEMS sensor device, Sensors and Actuators B: Chemical, vol. 401, 2024, 134891, ISSN 0925-4005.
7. Seniye Karakaya, Leyla Kaba, Wrinkle type nanostructured of Al-Ce co-doped ZnO thin films for photocatalytic applications, Surfaces and Interfaces, vol. 44, 2024, 103655, ISSN 2468-0230.
8. Zinc oxide nanostructures: Synthesis and characterization, Sotirios Baskoutas, ISBN: 9783038973034, 3038973033, Editor MDPI, 2018.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course			
11.5 Seminary/laboratory/project	Knowledge of general theoretical notions regarding nanostructured materials	Verification of the execution of the project theme	50%
	The capacity of synthesis necessary for the project	Solving a requirement within the project;	25%
	Notions regarding the Investigation of morphological, structural, optical and electrical properties.	Detailing an experimental process parameter.	25%
11.6 Passing conditions			
Obtaining 50% of the total score, the student can define the nanostructured materials. Obtaining 50% of the activity score during the semester, the student will interpret the results obtained. Compliance with the UNSTPB regulation on promotion conditions.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The increasing complexity of electronic circuits and systems and the need to reduce costs and research-design-manufacture cycles have imposed the development of computer-aided simulation, design and optimization techniques, in the form of various software tools.

The discipline provides graduates with adequate skills with the needs of current qualifications and modern, quality and competitive scientific and technical training.

Thus, the graduates are provided with a modern, quality and competitive scientific and technical training that will allow them to be hired quickly after graduation, being perfectly framed in the politics of the university both in terms of content and structure, and in terms of skills and international openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
01.09.2024	Colaborator Dr. Anca-Ionela Istrate	Colaborator Dr. Anca-Ionela Istrate

Date of department approval	Head of department
31.10.2024	Prof. Dr. Claudius DAN

Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea