Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

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)				Functiile dispozitivelor semiconductoare Functions of semiconductor devices			
2.2 Course Lecturer				S.l./Lect. Dr. Miron Cristea			
2.3 Instructor for practical activities				S.l./Lect. Dr. Miron Cristea			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.05-10		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
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.					55
Tutoring					0
Examinations					28
Other activities (if any):					0

3.7 Total hours of individual study	83.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	• Electronic devices • Electronic components
4.2 Results of learning	General knowledge of • Physics • Electronic devices • Simulation software for Electronics

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

5.1 Course	• The course is presented using an overhead projector and a laptop
5.2 Seminary/ Laboratory/Project .	Teaching is based on using software tools for semiconductor device design

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)*

This discipline is studied within the Electronics field of specialization and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications and problems, with relevance for stimulating the learning process in students.

The discipline addresses the following basic/advanced notions, specific concepts and principles as a specific topic, all of which contribute to the transmission/formation of students with an overview of the methodological and procedural benchmarks related to the field.

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	C1. Using fundamental elements relating to the circuits, systems, instrumentation, and electronic technology C4. Design, simulation and testing devices, integrated circuits and micro and nano-systems with modern software tools C5. Electronic devices and integrated circuits modeling using latest modern micro and nanotechnologies C6. Design, simulation and testing of devices, circuits, and optoelectronic systems with modern software tools and micro and nanotechnologies.
Transversal (General) Competences	**CT3** Adapting to new technologies, professional and personal development through training using printed documentation sources, specialized software, and electronic resources in Romanian and at least one foreign language.

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.* **• Lists the most important stages that marked the development of the field.** **• Defines domain-specific notions.** **• Describes/classifies notions/processes/phenomena/structures.** **• Highlights 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 in a given context.** **• Reasonably uses specific principles.** **• Work productively in a team.** **• Elaborate a scientific text.** **• Solve practical applications.** **• Adequately interpret causal relationships.** **• Analyze and compare.** **• Identifies solutions and develops solution/project plans.** **• Formulates conclusions to the experiments carried out.** **• Sustain the identified solutions/solutions**

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Select appropriate bibliographic sources and analyze them. • Respect the principles of academic ethics, correctly citing the bibliographic sources used. • Demonstrates responsiveness to new learning contexts. • Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities • Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved • Demonstrates social responsibility through active involvement in student social life/involvement in academic community events • Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. • Realizes the value of his contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). • Apply principles of professional ethics/deontology in the analysis of the technological impact of the proposed solutions in the specialized field on the environment. • Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialized field. • Demonstrates real-life situation management skills (collaborative vs. conflict time management)**.**

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.)*

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

In the teaching activity, lectures will be used, based on Power Point presentations or different videos that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.

Presentations use images and diagrams so that the information presented is easy to understand and assimilate.

This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.

It will be considered the practice of active listening and assertive communication skills, as well as feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.

Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE

Chapter	Content	No. hours
1	Introduction • Functional electronics – what is it? • Analog computational structure and function • Dimension and complexity	2
2	Analogic computation • The mathematical functions of semiconductor devices • The analog machine, Computing Analog Blocks (CABs) • Programming with electric field, FPAA structure • Trans-linear circuits	2
3	The abstract model of analog computing machine • The analog-computational synergic hierarchy • The family of computational semiconductor devices	2
4	Non-linear algebra on the family of semiconductor devices • Limited IO computability • Signal conditioning	2
5	Computation with mathematical functions given by MOS transistors. • The mathematical functions of MOS general physical models – the linear function, the quadratic function • The mathematical functions used in modelling – arctan, square root, tanh • The mathematical functions of the static models of subthreshold conduction - exponentials	6
6	Computation with mathematical functions given by types of MOS transistors • The mathematical functions of multi–gate MOS transistors • The mathematical functions of SOI - MOS transistors (Silicon On Insulator) – linear • The mathematical functions of other MOS transistors: Trench-gate, SiC	6
7	Computation with mathematical functions of bipolar transistors • The mathematical functions from general models of bipolar junction transistor - exponential • Function particularities at low/high injection levels • Function particularities of SiC bipolar transistor	4
8	Computation with mathematical functions of semiconductor diodes • Mathematical functions of p-n diodes - exponential • Mathematical functions of Schottky diode - exponential • Mathematical functions of gated diode - linear • Functions derived from parasitic elements - linear	4
	Total:	28

Bibliography:
Miron Cristea, Functions of Semiconductor Devices. Ed. Matrix Rom, 2024

Online materials https://archive.curs.upb.ro/2022/course/view.php?id=10430
Rusu, A., “Non-linear Electrical Conduction in Semiconductor Structures”, Romanian Academy Publishing House, 2000
L. Dobrescu, D. Dobrescu, „ Advanced Models for MOS Devices”, Printech Publishing House, Bucharest, 2002
L. Dobrescu, D.Dobrescu, "Basics of the Semiconductor Devices Physics", 142 pg., Printech Publishing House, ISBN 973-718-364-9, Bucharest, 2005
M. Cristea, “Power Semiconductor Devices”, PoliPress, 2016
http://helpme.scudc.scu.edu/hspice2001/hspice_and_qrg/hspice_2001_2-168.html
http://www. radio-electronics.com/info/data/semicond/fet-field-effect-transistor/trenchmos-gatetransistors.php
http://www.ele.uri.edu/courses/ele448/HspiceRef/hspice_mosmod.pdf

LABORATORY

Crt. no.	Content	No. hours
1	Design and modeling of a MOS transistor with functional optimization.	4
2	Design and modeling of a bipolar transistor with functional optimization.	4
3	Design and modeling of a semiconductor diode with functional optimization	4
4	Final test	2
	Total:	14

Bibliography:
Miron Cristea, Functions of Semiconductor Devices. Ed. Matrix Rom, 2024
Online materials https://archive.curs.upb.ro/2022/course/view.php?id=10430
M. Cristea, “Power Semiconductor Devices”, PoliPress, 2016
A. Rusu, “Non-linear Electrical Conduction in Semiconductor Structures”, Romanian Academy Publishing House, 2000

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- fundamental functioning principles; - basic knowledge for advanced modeling and simulation of electronic devices	Presentation of scientific results from research and outstanding verification test exam at the end of the semester held at a date fixed during the exam session	40%

11.5 Seminary/laboratory/project	- applying specific design and simulation techniques using simulators. - understanding the influence of model parameters and parasitic elements on device functions.	The assessment is cumulated for two intermediate moments: design verification and final verification. It includes: 1.Correctness of activity results 2. A parameter model must be detailed and its influence on the device functions must be explained	60%
11.6 Passing conditions			
Obtaining 50% of the total score. Obtaining 50% of the score related to the activity during the semester.			

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 – manufacturing-research-design cycle required the development of simulation techniques, computer aided design and optimization in the form of various software tools.
- The course provides graduates' appropriate skills for the current qualifications needs and a competitive and modern scientific and technical knowledge.
- Providing a scientific and technical training for graduates to obtain a rapid employment after graduation, being perfectly integrated in National University of Science and Technology POLITEHNICA Bucharest policy, both in terms of content and structure, and from the point of view of skills and international openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
22.10.2024	S.l./Lect. Dr. Miron Cristea	S.l./Lect. Dr. Miron Cristea

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

Date of approval in the Faculty Council	Dean

Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

01.11.2024 Prof. Dr. Mihnea Udrea