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	Microsystems

2. Date despre disciplină

2.1 Course name (ro) (en)				Modelarea şi caracterizarea experimentală a microstructurilor integrate			
2.2 Course Lecturer				Prof. Dr. Dragos Dobrescu			
2.3 Instructor for practical activities				Prof. Dr. Dragos Dobrescu			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type	DS		2.9 Course code	UPB.04.M1.O.03-02		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.					15
Tutoring					14
Examinations					29
Other activities (if any):					0

3.7 Total hours of individual study	58.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Fundamental Courses of Electronic Devices, Models of electronic components for Spice, Modelling of Active Microelectronic Components

4.2 Results of learning	General knowledge of physics, electronic devices and software simulation of electronic circuits

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

5.1 Course	The course will take place in a room equipped with a video projector or on the MSTeams platform
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)*

For the course: The course is addressed especially to graduates with a bachelor's degree in Electronic Engineering, Telecommunications and Information Engineering, Electrical Engineering and Applied Engineering Sciences.The need for modeling and characterization of integrated electronic structures, as fundamental elements of the current integrated circuits, it is imposed due to their increasing complexity, as well as the need to obtain high-performance circuits with acceptable cost prices. The discipline presents the fundamental concepts of the field of modeling from microelectronics, bringing to the students original ideas and methods of the Romanian school. Among these can be listed the nonlinear electrical conduction theorem and the unified model of the MOS transistor belonging to prof. A. Rusu.

For applications: Checking the theories acquired in the course by performing analytical calculations, modeling and/or the simulation of an electronic device or circuit or an integrated microsystem.Competences provided by the study of the discipline fall within the area of those necessary for the research and development of new devices and integrated circuits, made with modern methods and technologies.Placing in the 1st semester takes into account the cognitive sequence necessary for the formation of a performant specialist in the field of microsystems, as well as the interdisciplinary nature of the master's programme.Discipline can be regarded as fundamental to ensuring engineering skills for research-development or design in the field of complex integrated microsystems.

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	Knowledge of how micro and nanoelectronic devices work; - Design of circuits with MOS nanometric transistors, low working voltages and low power consumption; Effective correlation between function and structure in defining, designing and performing programmable (complete) SoCs; Knowledge of current technological aspects and understanding their effect on the realization of analog integrated circuits that are part of analog-digital mixed CMOS VLSI systems; Knowledge of advanced technological processes for micro and nano-scale electronic devices; - Use of software tools for advanced simulation of both devices and technological processes;
Transversal (General) Competences	- Developing the experimental skills necessary for the technological realization, modeling and characterization of new micro and nanoelectronic devices and circuits; - Responsible execution of multidisciplinary teamwork tasks, assuming roles on different hierarchical levels; Identifying the need for continuous training and efficient use of information sources and communication resources and assisted professional training (internet portals, specialized software applications, databases, online courses, etc, etc.) both in Romanian and in a language of international circulation.

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 fundamental models of MOS transistors Define model parameters Describe/classify model parameters Highlights the peculiarities of special constructive solutions
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).* Select and group relevant information about MOS transistor models. Arguably uses specific principles of TCEN Work productively in a team to carry out the project. Elaborates a scientific text in drafting the project Solves practical applications within the project It interprets proper causal relationships Analyze and compare models Identifies solutions and elaborates the discipline project. Conclusions on the experiments carried out. Arguments the solutions identified in the project .

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 quoting the used bibliographic sources. Demonstrate responsiveness for new learning contexts. Demonstrates collaboration with other colleagues and teachers in carrying out teaching activities Demonstrates autonomy in organizing the learning situation/context or problem-solving situation Promotes/contributes through new solutions, related to the specialty field. Awareness of the value of its contribution to the field of engineering in identifying viable/sustainable solutions Apply ethical principles

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 learning by discovery models facilitated by direct and indirect exploration of reality (experiment, demonstration, modeling), but also on action-based methods such as exercise, exercise, and, 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 students will be checked by rapid tests (quizz) during or at the end of the course at certain courses.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**

1	1 Active electronic component 1.1 Electronic components 1.2. Elementary electronic functions 1.3. An attempt to delineate the field of electronics 2 2 Nonlinear electrical conduction theorem (NTC) 2.1. Observations on mathematical functions describing nonlinear electrical conduction 2.2. Law of electrical conduction phenomena 2.3. Theorem of nonlinear electrical conduction 2.4. Examples of application of TCEN 4 3 Nonlinear electrical conduction in homogeneous semiconductors 3.1. Electric charge transport phenomena in semiconductors 3.2. Mobility of load carriers 3.3. Junction field effect transistor	2
2	Nonlinear electrical conduction theorem (NTC) 2.1. Observations on mathematical functions describing nonlinear electrical conduction 2.2. Law of electrical conduction phenomena 2.3. Theorem of nonlinear electrical conduction 2.4. Examples of application of TCEN	4
3	Nonlinear electrical conduction in homogeneous semiconductors 3.1. Electric charge transport phenomena in semiconductors 3.2. Mobility of load carriers 3.3. Junction field effect transistor	2
4	Optimal extraction of model parameters of integrated semiconductor structures 4.1. Definition of model parameters 4.2. Experimental measurement of model parameters 4.3. Methods of optimal extraction of model parameters 4.4. Parameter validation by simulation of integrated circuits	4
5	Mos Capacitor. Field induced junction. 5.1. Physical phenomena in the MOS capacitor 5.2. Analytical models for the MOS capacitor 5.3. The MOS capacitor dynamic regime	4
6	The gate junction 6.1 yeah. MOS capacitor threshold voltage in non-equilibrium regime 6.2. The dynamic regime of the non-equilibrium MOS capacitor 6.3 "I. Static electrical feature of the gate junction	6

7	Advanced models of MOS transistors from integrated structures 7.1 yeah. Static models in strong inversion (above the threshold) and in poor inversion (below the threshold) 7.2. Short channel effects 7.3. Unified models 7.3.1 yeah. The Tsividis model 7.3.2 yeah. The EKV 7.3.3 yeah. The ENSERG model 7.3.4. The Russian Model 7.4. MOS transistor dynamic regime	6
	Total:	28

Bibliography:

1. D. Dobrescu, MCEMI, https://curs.upb.ro/2023/enrol/index.php?id=9676
2. A. Rusu, “Modelarea Componentelor Microelectronice Active”, Editura Academiei Romane, 1990.
3. A.Rusu, „Conductie electrica neliniara in structuri semiconductoare”,Editura Academiei Romane, Bucuresti, 2000;
4. L. Dobrescu, D. Dobrescu, „Modele avansate ale dispozitivelor MOS”, Editura Printech, Bucuresti, 2002;
5. L. Dobrescu, D.Dobrescu, "Basics of the Semiconductor Devices Physics", 142 pg., Ed. Printech, ISBN 973-718-364-9, Bucuresti, 2005.

LABORATORY

Crt. no.	**Content**	**No. hours**
1	Presentation of equipment and comparative presentation of programs available for modeling and simulation of electronic devices and circuits	4
2	Application of TCEN for modeling the asymptotic behavior of semiconductor devices	10
	Total:	

Bibliography:

1. https://curs.upb.ro/2023/enrol/index.php?id=9676
2. L.Dobrescu, „Modele avansate ale dispozitivelor MOS”, Editura Printech, Bucuresti, 2002;
3. D. Dobrescu , L.Dobrescu, “Dispozitive si Circuite Electronice-Caiet de Activitate”, 158 pag., Ed. Printech, ISBN 973-652-829-4, Bucureşti, 2003;
4. A. Rusu, D. Dobrescu, L. Dobrescu, “Dispozitive si Circuite Electronice note de curs si probleme rezolvate”, 90 pg., Ed. Printech, ISBN 973-652-828-6,Bucuresti, 2003;

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	knowledge of the fundamental theoretical concepts of advanced modelling;	Written exam in session	50%

11.5 Seminary/laboratory/project	laboratory: modelling and/or simulation of an electronic device or circuit or an integrated microsystem	check during the semester	50%
11.6 Passing conditions			
Obtaining 50% of the laboratory and project score from the semester time. 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 Polytechnic University of Bucharest, both in terms of content and structure, and in terms of international skills and openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
01.09.2024	Prof. Dr. Dragos Dobrescu	Prof. Dr. Dragos Dobrescu
		Conf. Dr. Gheorghe Pristavu

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