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)				Modelarea avansată a tranzistoarelor MOS Advanced MOSFEts Modelling			
2.2 Course Lecturer				Prof. Dr. Lidia Dobrescu			
2.3 Instructor for practical activities				Prof. Dr. Lidia Dobrescu			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.05-01		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	1.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	14	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.					20
Tutoring					5
Examinations					22
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	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 laboratory will be conducted 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)*

The general objective of the discipline is to present advanced models for MOS transistors, highlight special constructive types, advanced design solutions, and, cutting-edge technologies and implementation of specific parameters in models.It can be achieved by:

Highlighting and description of specific parameters of advanced models for MOS transistors;

Presentation of special types of MOS transistors: power devices, mobile gate transistors, FINFETs, Trench-Gate, etc; - Presentation of advanced design solutions for MOS devices and circuits; - Presentation of leading technologies in the field of MOS transistors with submicron dimensions; - Comparative presentation of modeling and simulation environments. Comparisons, highlighting some advantages and disadvantages; - Presentation of modern trends in modeling MOS transistors; - Practical application of models for MOS transistors in the design of an oscillator in the ring; - Presentation of models

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Presentation of advanced design solutions for MOS devices and circuits;

Presentation of leading technologies in the field of MOS transistors with submicron dimensions

Presentation of modern trends in the modeling of MOS transistors;

Practical application of models for MOS transistors in the design of an oscillator in the ring;

Presentation of models

Presentation of special types of MOS transistors: power devices, mobile gate transistors, FINFETs, Trench-Gate, etc;

Presentation of advanced design solutions for MOS devices and circuits;

Presentation of leading technologies in the field of MOS transistors with submicron dimensions;

Comparative presentation of modelling and simulation environments. Comparisons, highlighting some advantages and disadvantages;

Presentation of modern trends in the modeling of MOS transistors;

Practical application of models for MOS transistors in the design of an oscillator;

Presentation of predictive models for MOS transistors

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	CT1 Adaptation to new technologies, professional and personal development, through continuous training using printed documentation sources, specialized software and electronic resources in Romanian and at least, 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 and several types of 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 the constructive types of MOS transistors. 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 solutions of the threshold voltage extraction by several methods. Solves practical applications within the project, processing measured data sets. Adequately interprets causal relationships between extracted values. Analyzes and compares the value of the threshold voltage. Identifies solutions and elaborates the discipline project. Draw conclusions to the experiments carried out and argue 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 models through discovery 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.In the teaching activity will be used lectures, based on Power Point 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 covered in the last course.The presentations use images and schemes, including, so that the information presented is easy to understand and assimilate.This discipline covers information and practical activities aimed at supporting students in their efforts to learn and develop optimal relationships of collaboration and communication in a climate conducive to learning through discovery.

10. Contents

COURSE	
Chapter	
1	ntroduction 1.1 . Course theme 1.2. Overview of specific objectives 1.3. Overview of the laboratory
2	2. Modeling the MOS transistor 2.1. General physical models 2.2. Constructive and polarizing elements 2.3. Approximations used in modeling 2.4. Static models in strong inversion
3	3. Advanced types of MOS transistors 3.1.MOS power transistors, lowside and highside topologies. 3.2. Variable mechanical microcapacitor 3.3.Finfet Transistors 3.4. MOS insulating transistors (SOI) 3.5.The Trench Gate MOS
4	4. Advanced design solutions 4.1. MOS transistor slope increase 4.2. Method Id/gm 4.3. Particularities introduced by the reduction of channel lengths and miniaturization 4.3.Leading technologies in the field of MOS transistors with submicron dimensions;

5	5. Modelling and simulation environments 5.1. SPICE simulators assembly 5.2. Cadence environment 5.3. LTSpice 5.4 Microcap
6	Predictive models

Bibliography:

1. L. Dobrescu, Modelarea Avansata a Tranzistoarelor MOShttps://curs.upb.ro/2024/course/view.php?id=7007
2. N.D Arora ,MOSFET Modeling for VLSI Circuits Simulation, https://books.google.ro/books?id=KwurCAAAQBAJ&pg=PA497&dq=MOSFET&hl=ro&s
3. R. J. Baker, „CMOS Circuit Design, Layout and Simulation ” https://books.google.ro/books? id=payXDwAAQBAJ&printsec=frontcover&dq=%E2%80%A2%09R.+J.+Baker,+%E2%80%9ECMOS+Circuit+Desig
4. L. Dobrescu, D. Dobrescu, „Modele avansate ale dispozitivelor MOS”, Editura Printech, Bucuresti, 2002;

LABORATORY

Crt. no.	Content	No. hours
1	LTSPICE environmental overview	4
2	Circuit simulation with a MOS transistor in LTSPICE	2
3	Models of MOS transistors in LTSPICE, particularities	2
4	Creating new MOS transistor models	2
5	Predictive Models	2
6	Amplification stages with MOS transistors, current mirrors	2
	Total:	14

Bibliography:

https://curs.upb.ro/2024/course/view.php?id=7007

L. Dobrescu, D. Dobrescu, „Modele avansate ale dispozitivelor MOS”, Editura Printech, Bucuresti, 2002;

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Theoretical presentation of MOS transistor models and advanced constructive solutions for modern MOS transistors	Presentation of ppt - oral during the semester	60%
11.5 Seminary/laboratory/project	The evaluation is done by testing the practical skills of simulating MOS transistor circuits	Evaluation of laboratory activity through practical tests cumulating scores during the semester	40%
11.6 Passing conditions			
Highlighting models for MOS transistors and their parameters. Presentation of special types of MOS transistors. Obtaining 50% of the laboratory colloquium score. Obtaining 50% of the ppt oral presentation score during the semester. 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.Discipline provides graduates with adequate skills with the needs of current qualifications and modern scientific and technical training, quality and competitive. 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 National University of Science and Technology Politehnica 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. Lidia Dobrescu	Prof. Dr. Lidia Dobrescu

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