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 proceselor de fabricatie pentru proiectarea circuitelor integrate Modeling of manufacturing processes for the design of integrated circuits			
2.2 Course Lecturer				S.l./Lect. Dr. Ovidiu George Profirescu			
2.3 Instructor for practical activities				S.l./Lect. Dr. Ovidiu George Profirescu			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type	DA	2.9 Course code		UPB.04.M3.O.05-32		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.					17
Tutoring					0
Examinations					16
Other activities (if any):					0

3.7 Total hours of individual study	33.00
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, Fundamental Electronic Circuits, Integrated Analog Circuits.
4.2 Results of learning	General knowledge of physics, mathematics, electronic devices and electrical measurements.

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 take place inside ONSEMI Romania, in a laboratory at industrial standards, thus ensuring a binder between the acedemic environment and the industrial environment in which they will be active after the completion of studies. This ensures the alignment of taught knowledge with current technological development.

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)*

Presentation of manufacturing process modeling in the semiconductor industry for the development of integrated circuit design software tools;

- highlighting and describing the file sets resulting from the manufacturing process of semiconductor devices (PDK-process design kit) as input data;

- presentation of a PDK library;

- presentation of VLS simulation media;

presentation of advanced VLSI layout solutions and cell parameterization;

- presentation of some verification rules (checking the design and extraction rules);

- presentation of post layout simulation (parasite PEX extractions and RC simulations);

familiarization of students with the industrial environment and with the modern laboratory equipment available to Onsemi Romania employees.

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 PDK parameters Defines the characteristic elements of VLSI manufacturing processes 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 Primitive Library of a device Arguably uses specific principles in order to preserve or neglect some model parameters. Work productively in a team to perform laboratory work. Elaborates a scientific text in the drafting of laboratory reports Experimentally check the design solutions within the laboratory. Solves practical applications within the laboratory, processing measured data sets. Adequately interprets causal relationships between extracted values. Analyzes and compares the measured values. Identify measurement solutions in the laboratory. Conclusions on the experiments carried out. Arguing the solutions identified .

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 Demonstrate 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. Introduction 1.1 "s. Course theme 1.2. Evolution of the integrated circuits field and future perspectives 1.3. Stages of precision integrated circuits design	2

2	2. Elements of VLSI 2.1. Basic elements in VLSI 2.2. Insulation of structures in CMOS/BICMOS technologies 2.3. MOS transistor gate control circuits 2.4. Protection and control circuits 2.5 Other circuits (bandgap, mirrors, capacitive multiplier)	10
3	Elements PDK 3.1. The primitive library of a device 3.2. Recognition of elements in the MOS transistor model 3.3 Technological data (layers, colors, description attributes, process constraints, electrical rules) 3.4 Manual of design rules	8
4	4. Presentation of VLSI simulation environments	4
5	5. Presentation of verification rules	2
6	6. Presentation of post layout simulation (parasite PEX extractions and RC simulations)	2
	Total:	28

Bibliography:

1. O. Profirescu https://curs.upb.ro/2023/course/view.php?id=9678
2. Sedra, Smith- Microelectronic Circuits, 2019
3. Razavi-Design of Analog CMOS Integrated Circuit, 2017
4. R. Jacob Baker – CMOS Circuit Design, Layout, and Simulation, 2010
5. Bruce Carter, Ron Mancini - Op Amps for Everyone, 2017

LABORATORY

Crt. no.	**Content**	**No. hours**
1	Operational amplifier. Definition. Applications with operational amplifiers. - Operational amplifier parameters. Dc Parameters. Parameters AC - Interpretation of a catalog sheet of an AO. Parameters, values and figures in the catalogue sheet electrical circuits used in AO testing. Presentation at component and function level - Methods of measuring AO - Tiles and test tools. - Export of data to computer - Processing of data on the computer	0
2	Measurement of the tape, phase edge and gain of the AO - Measurement of the closed loop curve Measurement of the time of returning from saturation - Measurement of the speed of tracing the output - Measurement of the output setting time - Presentation of the gap voltage measurement method - Presentation of the method of measurement of rejection parameters PSRR and CMRR - Presentation of the open loop amplification measurement method	0

3	IBIS and Spice models - What are IBIS and Spice models, and what are they used for? - Techniques for measuring I-V characteristics. - Techniques for measuring V-t characteristics.	0
4	Creating an IBIS model of a Digital Buffer. - Simulation using the created model.	0
5	Measurement of the tape, phase edge and gain of the AO - Measurement of the closed loop curve Measurement of the time of returning from saturation - Measurement of the speed of tracing the output - Measurement of the output setting time - Presentation of the gap voltage measurement method - Presentation of the method of measurement of rejection parameters PSRR and CMRR - Presentation of the open loop amplification measurement method	0
6	Design and simulation of a Widlar current source proportional to temperature (PTAT). Generating a reference voltage using the bandgap voltage principle. Convert the obtained reference voltage into a constant current with temperature.	0
7	Design and simulation of a two-storey operational amplifier and folded cascode. Understanding the basic parameters of an operational amplifier: lag voltage, noise, CMRR, PSRR, tape, phase edge.2	0
8	Colloquium Laboratory	0
	Total:	

Bibliography:
1. Microelectronic Circuits (The Oxford Series in Electrical and Computer Engineering)-Sedra, Smith, 2019
2. Razavi-Design of Analog CMOS Integrated Circuit, 2017
3. R. Jacob Baker – CMOS Circuit Design, Layout, and Simulation, 2010
4. Allen, Phillip E. Holberg, Douglas R - CMOS analog circuit design, 2011
5. Bruce Carter, Ron Mancini - Op Amps for Everyone, 2017

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Exam	The evaluation is done by written verification exam at a fixed date during the exam session.	40%
11.5 Seminary/laboratory/project	Colloquium Laboratory	The evaluation is made at a final verification deadline: 1. verification of the acquired technical skills 2. the degree of understanding of the significance of the results.	30%
	Homework	Checking the house theme will take place in the second part of the semester	30%
11.6 Passing conditions			
Obtaining 60% of the laboratory score in the semester time.			

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)

Increasing the complexity of electronic circuits and systems and the need to reduce costs and research-design-manufacturing 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.

The discipline also ensures a synergy between academia and industry, introducing students into the industrial environment through the laboratories that take place in Onsemi Romania.

Date	Course lecturer	Instructor(s) for practical activities
01,09,2024	S.l./Lect. Dr. Ovidiu George Profirescu	S.l./Lect. Dr. Ovidiu George Profirescu
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