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 avansata a circuitelor analog-digitale Advanced modeling of analog-digital circuits			
2.2 Course Lecturer				Colaborator Dr. Mihai Crăciun			
2.3 Instructor for practical activities				Colaborator Dr. Mihai Crăciun			
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.M2.O.05-09		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.					16
Tutoring					0
Examinations					28
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, Electronic Circuits

4.2 Results of learning	General knowledge of physics, electronic devices, electronic circuits 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)*

Over the last few decades, integrated circuits have evolved from single-function chips to complex single-chip systems. Such modern on-chip (SoC) systems include digital signal processors, microcontrollers, RF and analog circuits to provide the necessary interface for the real physical world of signals from sensors, to, audio/video interfaces, electronic signals or wireless communications. These / (AMS) analog mixed signal systems require co-integration, co-design, and co-verification of analog-to-digital circuits on the same CMOS technology platform. In this course, we will study:

implementation of analog /digital mixed circuits using behavioral modeling, as an essential tool in the design flow of AMS systems.

critical comparison of analog and digital circuit solutions in a given applicative context in terms of signal quality, energy consumption, costs and flexibility, and,

analysis of sources and propagation of analog non-idealties in a mixed signal chain,

generate appropriate solutions for analog blocks and model their high-level behavior in Verilog-AMS language

Configuring an appropriate methodology for the design, simulation and verification of a mixed signal system from the specification phase to the block partitioning phase to physical implementation , co-simulation and co-verification of analog blocks with a digital circuit in Verilog to extract the specifications for the implementation of the mixed signal circuit,

analysis of catalog sheets of an electronic system in the framework of a design project,analysis of a scientific work in the field of circuits and electronic systems

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 types of electron circuits Defines the specific parameters of analog-digital circuits 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).* Selects and groups relevant information about the types of electronic circuits 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 seminar and project. Solves practical applications within the project, calculating data sets 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. 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. Introduction 1.1 "s. Course theme 1.2. Overview of the course structure and specific objectives 1.3. Project overview	2
2	2. Methodology of designing AMS systems	2

3	3. Behavioral modeling	6
4	4. Analog signal testing 4.1. Properties of analog circuits 4.2. Analogue circuit testing	6
5	5. Testing of mixed systems 5.1. Introduction to DAC and CAD conversion 5.2.ADC and DAC circuit structure 5.3. ADC/DAC specifications and error models 5.4.IEEE1057 standard	8
6	6. Conclusions and applications	4
	Total:	28

Bibliography:

M. Craciun -https://curs.upb.ro/2021/enrol/index.php?id=9535
A. Rusu, „Conductie electrica neliniara in structuri semiconductoare”,Editura Academiei Romane, Bucuresti, 2000;
L. Dobrescu, D. Dobrescu, „Modele avansate ale dispozitivelor MOS”, Editura Printech, Bucuresti, 2002;
Laung-Terng Wang Cheng-Wen Wu Xiaoqing Wen VLSI TEST Principles and Architectures, Morgan Kaufman Publishers, Elsevier 2006,ISBN 13: 978-0-12-370597-6 ISBN 10: 0-12-370597-5

PROJECT

Crt. no.	Content	No. hours
1	Behavioral modeling of passive and active elements;	1
2	Behavioral modeling of hysteresis comparator and delay circuits;	1
3	Behavioral modeling of the control circuit for power MOS transistors;	1
4	Behavioral modeling of protective blocks (over-current, over temperature, over-voltage);	1
5	Behavioral modeling of consumer circuits, solving convergence errors;	1
6	Checking a behavioral model.	1
7	Final verification	1
	Total:	7

Bibliography:

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;
Laung-Terng Wang Cheng-Wen Wu Xiaoqing Wen VLSI TEST Principles and Architectures, Morgan Kaufman Publishers, Elsevier 2006

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 simulation and calculation of circuits basic knowledge of voltage and current references	80%(40% exam issue+40% test during semester)	80%

11.5 Seminary/laboratory/project	Project verification	verification	20%
11.6 Passing conditions			
Obtaining 50% of the laboratory score and the project score in the semester time. Compliance with the UNSTPB regulation on promotion conditions. Modeling high-level systems behavior in Verilog-AMS language.			

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. Mihai Crăciun	Colaborator Dr. Mihai Crăciun

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

Date of approval in the Faculty Council	Dean

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01.11.2024 Prof. Dr. Mihnea Udrea