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)				Verificare functionala a circuitelor			
2.2 Course Lecturer				S.L. Dr. Ing. Miron Cristea			
2.3 Instructor for practical activities				S.L. Dr. Ing. Miron Cristea			
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.03-20		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	4	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	28
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.					42
Tutoring					0
Examinations					2
Other activities (if any):					0

3.7 Total hours of individual study	44.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Foundaments of electronic devices, component modelling, usage of SPICE based simulation programs

4.2 Results of learning	Introduction in the test proces, gain familiarity with test equipment both manual and automatic. Gain knowledge about implementation of test support blocks as a part of general design. Gain knowledge about specific testing methods for integrated circuits.

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

5.1 Course	Rooms with video-projectors or MS Teams access.
5.2 Seminary/ Laboratory/Project	Rooms for the laboratory with video-projectors and internet connection. A minimum of 15 computer workstations with dedicated electronic circuit simulation software.

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: Target audience is the alumni from Electrical, Telecomunication and Information Technology Engineering or Engineering Applied Sciences Departments.

Verification and characterization of the integrated circuits os a major step in the development process. This course present an introduction to the test engineer role and to the role of component verification engineer role for mixed mode integrated circuits.

During the project a DFT module will be developed to emulate a real DFT block used in mass production testing.

The knowledge gained during this study is a part of the required skills for new circuits development.

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 a modern project management system with emphasis on the role of a test engineer. Presentation of manual and automated testers and their specific programming methods. Analysis of a production process starting from quality indices such as cp, cpk and yield. Notions of primary troubleshooting of unwanted behaviors of mixed circuits. Development of a DFT block.

Transversal (General) Competences	Development of experimental skills necessary for 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 resources for communication and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian language and in an international language. Using an editing and simulation program (Cadence) for electronic circuits.

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.* • Understanding the role of a test engineer within an electronic circuit development team. • Understanding a datasheet associated with an electronic device. • Development of an automated testing algorithm. • Design and implementation of a DFT module.
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).* • Work productively in a team to carry out the project. • Elaborates a scientific text in drafting the project • Solves practical applications within the project • Interpret causal relationships appropriately • Analyze and compare models • Identifies solutions and elaborates the project of the discipline. • Formulate conclusions to the experiments performed. • Substantiates the solutions identified within the project.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selection and analysis of appropriate bibliographic sources. • Respect for the principles of academic ethics, correctly citing the bibliographic sources used. • Demonstrates responsiveness towards new circuit architectures. • Collaborates with other colleagues and teaching staff in undertaking didactic tasks. • Demonstrates autonomy in organizing the learning situation/context or the problem-solving situation. • Contributes, through new solutions related to electronic circuits, to improving the quality of social life. • Realizes the value of personal contributions in the field of engineering for identifying viable/sustainable solutions to solve problems in social and economic life (social responsibility). • Applies principles of professional ethics/deontology in analyzing the technological impact of proposed solutions on the environment. • Analyzes and exploits opportunities for entrepreneurial development in the specialized field. • Demonstrates management skills in real-life situations.

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.)*

Demonstration, exposition, exercise and problem solving are used at the project meetings. Concrete situations of design, simulation and testing of integrated circuits (relaxation oscillator) are presented. The students' direct involvement in solving problems and their creativity in designing the block schematics that make up the complex circuit are stimulated.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	The role of the test ingineer within the a project development process - Project timeline description - Specific contribution for the project phases: definition, concept, implementation and characterization	2
2	General description of the characterization process: - Production cycle presentation - Specific differences between prototype testing and mass production testing	4
3	Test plan generation: the role of th product datasheet - Electrical characteristics - Block diagram - Specific caracterization data	2
4	Test plan generation: additional details - Test plan structure - Test diagram structure - Additional measurements outside of the datasheet	4

5	Analisys of the production process using statistic indicators: - Cp/cpk definition - LSL, USL, Z LSL, Z USL definiton - Relations between production stability, yield and cp, cpk values	4
6	Specific tests: - Continuity, leakage currents, current consumption - Specific testing for refference currents and voltages - Testing of dynamic signals - Specific errors in the measurement process	6
7	Test process improvements: - Specific terms - Calibration - Initial data analysis - Testing using ATE - Manual testing	6
	Total:	

Bibliography:

M. Burns and G. Roberts: An introduction to mixed-signal IC test and measurements; Oxford University Press, 2001; ISBN 0-19-514016-8
W. K. Lam: Hardware Design Verification: Simulation and Formal Method-Based Approaches, Prentice Hall Publishing House, ISBN 9780131433472
M, Stephens, D. Rosenberg: Design Driven Testing, Apress, 2011; ISBN 1430229446

SEMINARY

Crt. no.	**Content**	**No. hours**
1	Simulation enviroment presentation and project design targets	6
2	Sub-blocks development and top assembly	20
3	Project presentation	2
	Total:	28

Bibliography:

M. Burns and G. Roberts: An introduction to mixed-signal IC test and measurements; Oxford University Press, 2001; ISBN 0-19-514016-8
W. K. Lam: Hardware Design Verification: Simulation and Formal Method-Based Approaches, Prentice Hall Publishing House, ISBN 9780131433472
M, Stephens, D. Rosenberg: Design Driven Testing, Apress, 2011; ISBN 1430229446

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	General knowledge associated with the testing process	Written exam	30%
	Quality analysis of the production process	Verification during the semester	30%
11.5 Seminary/laboratory/project	Create a functional DFT module	Verification during the semester	40%

11.6 Passing conditions
Obtaining 50% of the total 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 discipline provides graduates with the creation of skills in the field of laboratory testing and automated testing, with emphasis on optimizing the production flow and increasing the quality of measurement data. Graduates get in touch with the real development and characterization process specific to the microelectronics industry with emphasis on mixed integrated circuits.

The discipline fits into the policy of the National University of Science and Technology Politehnica Bucharest, both in terms of content and structure and ensures an advantage on the specific market of the microelectronics industry.

Date	Course lecturer	Instructor(s) for practical activities
	S.L. Dr. Ing. Miron Cristea	S.L. Dr. Ing. Miron Cristea
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	