Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

# COURSE DESCRIPTION

## 1. Program identification information

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| 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 | Computers and Information Technology |
| 1.5 Cycle of studies | Bachelor/Undergraduate |
| 1.6 Programme of studies | Information Engineering |

## 2. Date despre disciplină

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|---|---|---|---|---|---|---|---|
| 2.1 Course name (ro)<br>(en) | | | | Instrumentaţie virtuală | | | |
| 2.2 Course Lecturer | | | | Conf. Dr. Alexandru Antonescu | | | |
| 2.3 Instructor for practical activities | | | | Conf. Dr. Alexandru Antonescu | | | |
| 2.4 Year of studies | 3 | 2.5 Semester | I | 2.6. Evaluation type | V | 2.7 Course regime | Ob |
| 2.8 Course type | D | 2.9 Course code | | 04.D.05.O.706 | | 2.10 Tipul de notare | Nota |

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

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|---|---|---|---|---|---|
| 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<br>Supplemental documentation (library, electronic access resources, in the field, etc)<br>Preparation for practical activities, homework, essays, portfolios, etc. | | | | | 76 |
| Tutoring | | | | | 10 |
| Examinations | | | | | 3 |
| Other activities (if any): | | | | | 0 |

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| 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)

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| 4.1 Curriculum | Completing and / or promoting the following disciplines:<br>• Electronic Measuring Instrumentation<br>• Fundamental Electronic Circuits<br>• Analog Integrated Circuits<br>• Digital Integrated Circuits<br>• Signals and systems |
| 4.2 Results of learning | Accumulate the following knowledge:<br>• Determining the main parameters of circuits and devices, in relation to the testing process<br>• Analysis of the accuracy of the test instruments, the relationship between them and the tested circuit, and the main limitations introduced in the case of the testing process by the equipment, the test circuit and the tested one |

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

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| 5.1 Course | • The course will take place in a room equipped with a video projector and computer. |
| 5.2 Seminary/ Laboratory/Project | • The laboratory will take place in a room with specific equipment, which must include: test equipment, modules for their control, computers with related software and the platform with the devices and circuits to be tested<br>• The following devices / circuits are required to carry out laboratory activities: semiconductor diodes, filters, amplifiers, voltage stabilizers, connectors, etc. |

**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)*

This discipline is studied within the specialization "Microelectronics, Optoelectronics and Nanotechnologies" and aims to familiarize students with the main approaches, models and explanatory theories of the field of testing of devices and integrated circuits.

The discipline addresses as a specific topic the following basic notions regarding circuit parameters, methods and specific limitations in the field of circuit testing.

**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.)*

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| **Specific Competences** | Development of configurations for evaluating the functionality of analog, digital and mixed circuits in integrated technologies. Implement these configurations in automated test systems<br>C4.1 Know and understand the principles and methods of designing analog, digital and mixed signal circuits, as well as the basics of micro-nanoelectronic technology. Circuit performance evaluation: speed, cost, reliability, scalability.<br>C4.2 Ability to select and use circuit topologies and technology (CMOS, BiCMOS or bipolar) appropriate to a specific circuit.<br>C4.4 Possibilities for selecting basic parameters for integrated circuits that define their electrical performance, reliability and operational safety<br>C5.1 Knowledge of concepts, tools and methods used in the advanced modeling process of semiconductor devices<br>C5.5 Simulation of electronic devices and circuits based on basic models and extraction of model parameters from specific electrical measurements.<br>C5.4 Establishing physical and technological limits in the design and construction of integrated circuit devices and modifying fundamental device models in accordance with nanometric dimensions. |
| **Transversal (General) Competences** | Work in a team and communicate effectively, coordinating efforts with others to solve situations of medium complexity.<br>Autonomy and critical thinking: the ability to think scientifically, to look for and analyze data independently, as well as to draw and present conclusions / identify solutions.<br>Ability to analyze and synthesize: summarizes the knowledge gained as a result of a systematic analysis process.<br>Respects the principles of academic ethics: in the documentation activity he correctly cites the bibliographic sources used.<br>Put into practice elements of emotional intelligence in the proper socio-emotional management of real life / academic / professional situations, demonstrating self-control and objectivity in making decisions or in stressful situations. |

**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.)*

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| **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.*<br>• List the most important stages of the testing process, the limitations imposed by the tested circuit, equipment and test board.<br>• Defines field-specific notions, in close relation to the tested circuit<br>• Describe / classify notions / processes / phenomena.<br>• Highlights consequences and relationships. |

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| **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).*<br>• Selects and groups relevant information in a given context.<br>• Arguably uses specific principles for abc.<br>• Work productively in a team.<br>• Experimentally verify identified solutions.<br>• Solves practical applications.<br>• Properly interprets causal relationships.<br>• Analyzes and compares the performance of similar circuits, following the testing process.<br>• Identifies solutions and develops solution plans / projects.<br>• Formulates conclusions from the experiments performed.<br>• Argues the identified solutions / solutions. |
| **Responsability and autonomy** | *The student's capacity to autonomously and responsably apply their knowledge and skills.*<br>Responsibility and autonomy • Select appropriate bibliographic sources and analyze their veracity.<br>• Respects the principles of academic ethics, correctly citing the bibliographic sources used.<br>• Demonstrates receptivity to new learning contexts.<br>• Shows collaboration with other colleagues and teachers in carrying out teaching activities<br>• Demonstrates autonomy in organizing the learning situation / context or problem situation to be solved<br>• Demonstrates social responsibility through active involvement in student social life / involvement in events in the academic community<br>• Promotes / contributes through new solutions, related to the specialized field in order to improve the quality of social life.<br>• Awareness of the value of his contribution in the field of engineering to the identification of viable / sustainable solutions to solve problems in social and economic life (social responsibility).<br>• Applies principles of professional ethics / deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment.<br>• Analyzes and capitalizes on business opportunities / entrepreneurial development in the specialized field.<br>• Demonstrates skills in managing real-life situations (time management, collaboration vs. conflict). |

**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.)*

Teaching is based on oral communication (the methods used are the expository method and the problematization method, used frontally). Where necessary, the video projector is used (covering the communication and demonstration function).

Students realize

(1) analysis of test systems specific to basic systems present in integrated circuits

(2) designs the code necessary for the automatic performance of tests for the acquisition and analysis of electrical parameters for low complexity integrated circuits.

**10. Contents**

| COURSE | | |
|---|---|---|
| **Chapter** | **Content** | **No. hours** |
| 1 | Introduction. Motivation. Overview of test methodology for digital, analog and mixed signal integrated circuits. Limitations and features of modern integrated circuit testing. | 2 |
| 2 | Continuous test and parametric tests. Continuity tests. Transfer feature of an analog system. Other parametric tests specific to analog systems. Characterization of references and stabilizers | 4 |
| 3 | Converter characterization techniques Characteristic parameters of the transfer of the converters. Merit factors used to characterize converters. Automation of converter testing. | 4 |
| 4 | Testing of analog and mixed data processing channels. . Introduction and terminology.<br>Dermination techniques of gain level. Determination of frequency and phase response.<br>Distortion characterization. Noise in analog data processing channels<br>Generation of test signals and reconstruction of signals acquired during the testing process. | 6 |
| 5 | Logic integrated circuit testing<br>Introduction to digital circuit issues<br>Types of defects and detection methods specific to combinational logic circuits, test limits and numerical complexity of test sequence generation methods. | 8 |
| 6 | Types of defects and detection methods specific to sequential logic circuits, test limits and numerical complexity of test sequence generation methods. | 4 |
| | **Total:** | 28 |

**Bibliography:**


- *Alexandru Mihai Antonescu, Testare și Instrumentație Virtuală pentru Microelectronică, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9479*
- *S.T.Chakadhar,A.D.Agrawal,M.L.Bushnell, "Neural Models and Algorithms for Digital Testing",Kluwer Academic Publishers,Boston*
- *M. Burns, G.W. Roberts, An Introduction to Mixed-Signal Ic test and Measurement*
- *M. Bushnell, V.D. Agarwal, Essentials of Electronics Testing*


| LABORATORY | | |
|---|---|---|
| **Crt. no.** | **Content** | **No. hours** |
| 1 | Familiarization with the programming environment for measuring instrumentation control | 3 |
| 2 | Design and automation of a test for the acquisition of the continuous transfer feature for analog system | 3 |
| 3 | Design and automation of a test for the generation and acquisition of dynamic test signals. Automatic characterization of a frequency filter | 6 |
| 4 | Design and automation of tests specific to the characterization of operational amplifiers | 6 |
| 5 | Final laboratory colloquium | 3 |

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| | **Total:** | 21 |

**Bibliography:**

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*S.T.Chakadhar,A.D.Agrawal,M.L.Bushnell, "Neural Models and Algorithms for Digital Testing",Kluwer Academic Publishers,Boston*
*M. Burns, G.W. Roberts, An Introduction to Mixed-Signal Ic test and Measurement*
*M. Bushnell, V.D. Agarwal, Essentials of Electronics Testing*

**11. Evaluation**

| Activity type | 11.1 Evaluation criteria | 11.2 Evaluation methods | 11.3 Percentage of final grade |
|---|---|---|---|
| 11.4 Course | 10.4 Lectures - knowledge of fundamental theoretical notions; - knowing how to apply the theory to specific problems. A written verification test (midterm) during the semester, held on a date set by the dean's office. Topics cover 50% of the subject matter consisting of exercises and modeling issues presented in the course. | A written verification test (midterm) during the semester, held on a date set by the dean's office. Topics cover 50% of the subject matter consisting of exercises and modeling issues presented in the course. | 40% |
| | 10.4 Lectures - knowledge of fundamental theoretical notions; - knowing how to apply the theory to specific problems. A written verification test (midterm) during the semester, held on a date set by the dean's office. Topics cover 50% of the subject matter consisting of exercises and modeling issues presented in the course. | Final exam in session with the possibility to repeat the midterm | 20% |
| 11.5 Seminary/laboratory/project | - knowledge of how to apply theoretical knowledge on electronic devices and circuits | A practical verification test scheduled at the last laboratory session, which aims to assess the degree of assimilation of knowledge specific to the laboratory activity | 40% |
| 11.6 Passing conditions | | | |
| Obtaining 50% of the total score.<br>Obtaining 50% of the 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)**

With the increasing degree of integration in digital, analog and mixed signal systems, testing specific to functionality increasingly involves methods dedicated to integrated implementations. Thus, the knowledge presented is useful in the design of integrated circuits - to ensure their testability - as well as in their testing. From the point of view of the representative employers in the field, a significant percentage of the graduates of the department of Microelectronics, Optoelectronics and Nanotechnologies start after employment by performing activities with specific testing of integrated circuits in the characterization groups or as test engineers. Approximately 50% of the employees of the present companies that carry out activities of design and development of integrated circuits are involved in the verification, characterization and development of production tests for these circuits.

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| Date | Course lecturer | Instructor(s) for practical activities |
| 25.09.2025 | Conf. Dr. Alexandru Antonescu | Conf. Dr. Alexandru Antonescu |
| Date of department approval | Head of department | |
| | Prof. Dr. Claudius Dan | |
| Date of approval in the Faculty Council | Dean | |
| 26.09.2025 | Prof. Dr. Mihnea Udrea | |