Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

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	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Instrumentaţie electronică de măsură Electronic Measuring Instruments			
2.2 Course Lecturer				S.l./Lect. Dr. Adrian Florin Paun			
2.3 Instructor for practical activities				S.l./Lect. Dr. Adrian Florin Paun			
2.4 Year of studies	3	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.05.O.004		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	4.5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2.5
3.4 Total hours in the curricula	63.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	35
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.					56
Tutoring					0
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	62.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Successful completion of the following courses: - Measurements in Electronics and Telecommunications - Electronic Devices - Signals and Systems I - Signals and Systems II - Digital Integrated Circuits
4.2 Results of learning	Understanding signal characterization in time and frequency domains Analog and digital signal processing methods Fundamental concepts and methods related to electronic devices and circuits

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

5.1 Course	The course will take place in a classroom equipped with a projector
5.2 Seminary/ Laboratory/Project	The seminar requires a classroom with a projector The laboratory requires a specially equipped room, including: - Signal generators, oscilloscopes, voltmeters - Passive components (resistors, inductors, capacitors) - Active components (diodes, transistors) - Breadboards - Connection cables

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 course is part of the Electronic Engineering, Telecommunications, and Information Technologies domain, specializing in Applied Electronics. It aims to familiarize students with the fundamental principles of electronic measuring and control instruments.
Students will gain knowledge of specific functional blocks, experiment evaluation capabilities, and theoretical models used for practical applications.
The course covers advanced measurement techniques for various physical quantities and corresponding equipment, preparing students for performing complex measurements in electrical and electronic circuits relevant to modern communication 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	Demonstrates advanced knowledge of measurement instruments in electronics. Applies standardized methods and digital measurement tools for evaluation and diagnosis. Analyzes and justifies measurement techniques using key concepts and methodologies. Communicates effectively using scientific vocabulary in English, both in writing and orally.

Transversal (General) Competences	Works effectively in teams, coordinating efforts to solve medium-complexity problems. Demonstrates autonomy and critical thinking by independently searching and analyzing data. Synthesizes and presents knowledge systematically. Adheres to academic ethical principles, correctly citing bibliographic sources. Applies emotional intelligence in social and professional contexts, making objective decisions under stress.

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.* Identifies the basic principles of electronic measuring instruments. Defines measurement-related concepts and equipment. Describes functional blocks of measurement devices. Understands measurement consequences and relationships.
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).* Builds elementary circuits on a test board. Measures and graphically represents parts of the transfer function of a linear, time-invariant circuit. Studies an analog-to-digital conversion chain from the perspective of the architectures involved and their specific errors (successive approximation ADC, R-2R DAC, etc.). Decides on the performance of the measurement based on the parameters and limitations of the digital sampling oscilloscope used (analog bandwidth, sampling frequency, rise time, horizontal deflection coefficient, acquisition memory). Interprets datasheet specifications for different types of voltmeters (error, effective number of digits, common-mode or series-mode rejection). Measures impedances using various measurement methods (2-wire, 4-wire), comparing these methods to minimize measurement error. Measures and interprets distortions for different types of signals. Recognizes the importance of matching output and load impedance when connecting the signal/function generator to another device or circuit.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* The student: - Demonstrates receptiveness to new learning contexts. - Selects appropriate bibliographic sources and analyzes them. - Respects the principles of academic ethics, correctly citing the bibliographic sources used. - Shows collaboration with colleagues and teaching staff in carrying out academic activities. - Demonstrates autonomy in organizing the learning context/situation or the problem situation to be solved. - Shows social responsibility through active involvement in student social life / participation in academic community events. - Promotes/contributes new solutions, specific to the field of study, to improve the quality of social life. - Acknowledges the value of their contribution in engineering to identifying viable/sustainable solutions to solve problems from social and economic life (social responsibility). - Applies principles of professional ethics/deontology in analyzing the technological impact of proposed solutions in the field on the environment. - Analyzes and takes advantage of business/entrepreneurial development opportunities in the field. - Demonstrates management skills for 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.)*

The teaching process will explore both expository methods (lectures, presentations) and interactive methods based on discovery learning models, facilitated by direct and indirect exploration of reality (experiments, demonstrations, modeling), as well as action-based methods, such as exercises, practical activities, and problem-solving.
Lecture presentation will combine video projection for theoretical foundations, demonstrations, and schematics, as well as whiteboard usage for examples and justifications, with active student participation.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	General measurement techniques and measurement accuracy	2
2	ADC and DAC convertors	8
3	Digital Oscilloscope	4
4	Digital Voltmeters	2
5	Digital Impedance Measurement	4
6	Frequency and Time Interval Measurements	2
7	Direct Digital Synthesizer	2
8	Measurement in the frequency domain - spectrum analyzer	4
	Total:	28

Bibliography:
Course notes - Moodle site : https://curs.upb.ro/2025/course/view.php?id=1556
Analog Devices, Fundamentals of Sampled Data Systems Application Note (AN-282): https://www.analog.com/en/index.html.
Keysight Technologies, Impedance Measurement Handbook. A guide to measurement technology and techniques, 6th Ed, Appplication note: https://literature.cdn.keysight.com/litweb/pdf/5950-3000.pdf.
Keysight Technologies, Voltage measurement,https://www.keysight.com/main/editorial.jspx?ckey=2674680&cc=RO&lc=eng.
Keysight Technologies, Spectrum Analysis Basics – Application note 150", 2020, https://www.keysight.com/us/en/assets/7018-06714/application-notes/5952-0292.pdf.

LABORATORY

Crt. no.	Content	No. hours
1	Measurements in Steady-State Sinusoidal Regime	3
2	Distortion Measurement	3
3	ADC ans DACs	3
4	Digital Oscilloscope	3
5	Impedance Measurement	3
6	Digital Voltage Measurement	3
7	Final Practical Test	3
	Total:	21

SEMINARY

Crt. no.	Content	No. hours
1	Measurement Techniques and Accuracy	2
2	Digital-to-Analog Converters	2
3	Analog-to-Digital Converters	2
4	Digital Oscilloscope	2
5	Digital voltage measurement. Direct digital synthesizer	2
6	Digital measurement of impedance	2
7	Seminar Test	2
	Total:	14

Bibliography:
Seminar and laboratory notes - Moodle platform: https://curs.upb.ro/2025/course/view.php?id=1556
Laboratory platforms - available online at http://ham.elcom.pub.ro/iem-lab/index.html

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	The ability of students to apply theoretical concepts in a different, yet related context to the one in which they originally acquired that knowledge.	Written test on chapters 1-3.	15%
	- Mastery of fundamental theoretical concepts and understanding their application in specific cases.	Final Exam	40%
11.5 Seminary/laboratory/project	- Quality and accuracy of responses in test questions related to the prepared work. - Implementation of measurement circuits, definition of experiments, and evaluation of results	- Tests with questions from prepared work and evaluation of laboratory reports. - Final practical laboratory test.	30%
	- Ability to find optimal and efficient solutions in practical applications	Seminar Test	15%
11.6 Passing conditions			
Minimum 50% of the total score Minimum 50% of the laboratory final test score			

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)

Through the activities carried out, students develop skills for determining, in numerical form, the values of physical quantities necessary for the quantitative characterization of various objects and phenomena, for providing solutions to problems, and for proposing ideas to improve the existing situation in the field of electronic measurements.
In developing the course content, aspects described in specialized literature, as well as notes from manufacturers of measuring equipment, have been taken into account.
The course content is similar to that of courses conducted at universities such as MIT or TU Delft.
Through laboratory activities, teamwork in groups of two, as well as the final laboratory test, the course aims to develop graduates' abilities to manage practical situations they may encounter in real life.

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Date	Course lecturer	Instructor(s) for practical activities
29.09.2025	S.l./Lect. Dr. Adrian Florin Paun	S.l./Lect. Dr. Adrian Florin Paun

Date of department approval	Head of department

Date of approval in the Faculty Council	Dean