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	Bachelor/Undergraduate
1.6 Programme of studies	Microelectronics, Optoelectronics and Nanotechnologies

2. Date despre disciplină

2.1 Course name (ro) (en)				Senzori şi circuite de condiţionare a semnalelor			
2.2 Course Lecturer				S.l./Lect. Dr. Marius Enachescu			
2.3 Instructor for practical activities				As.Drd. Ing. Andrei Cătălin Dăescu			
2.4 Year of studies	3	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.D.06.O.411		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	3.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	42	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.					18
Tutoring					0
Examinations					1
Other activities (if any):					0

3.7 Total hours of individual study	19.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	• Physics, • Electronic devices, • Fundamental electronic circuits, • Integrated analog circuits, • Digital circuits • IEM
4.2 Results of learning	• Basic knowledge of physics, math, digital signal processing, decision and estimation, signal comverters, and SPICE language.

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

5.1 Course	• According to current UNSTPB regulations. • The room should have a beamer and a white/black board
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment, which must include: access to the software and/or hardware resources necessary to develop the experiments (LabVolt Platform, PC, Oscilloscope, Signal Generator, Multimeter, Adjustable Voltage Source).

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 field of Electronic Engineering, Telecommunications and Information Technologies / specialization Microelectronics, optoelectronics and nanotechnologies and presents a system composed of three types of circuits: 1) transducers for translating non-electric quantities into electrical counterparts; 2) appropriate signal conditioning circuits; and 3) analog-digital and digital-analog converters for signal discretization and for (auto-)calibration of the system.
– The aim is primarily to deepen the phenomena and concepts associated with mixed signal circuits that contain sensors and work at a maximum frequency of tens of kHz, viewed from the point of view of the system designer, as well as familiarizing students with the stages related to the development of an application "Internet-of-Things (IoT)" electronics.
– In conclusion, the focus are the fundamental notions regarding the techniques of measuring non-electric quantities by electrical systems. The main types of transducers that transform non-electric quantities into electrical quantities are presented. And finally, the corresponding signal conditioning circuits and signal discretization with the help of analog-digital converters are also described.

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 that he has basic knowledge corresponding to the chosen field of study: Familiarization of students with the issue of methods and techniques for measuring non-electric quantities by electronic means. Graduates of the discipline will be competent to understand the operation and effectively use the techniques specific to the acquisition of non-electric quantities by electronic methods. – Demonstrates understanding of the design specification and structuring of the electronic system into functional blocks. – Argue and analyze coherently and correctly the context of application of basic knowledge, using key concepts of related disciplines and their specific methodologies. – Oral and written communication in Romanian language: uses the scientific vocabulary specific to the chosen field of study, in order to communicate effectively and correctly, in writing and orally. – Oral and written communication in a foreign language (English): demonstrates the correct understanding and application of the vocabulary related to the chosen field of study, in a foreign language.
Transversal (General) Competences	– Works in a team and communicates effectively, coordinating efforts with others to solve problem situations of medium complexity. – Autonomy and critical thinking: the ability to think in scientific terms, to search and analyze data independently, to identify solutions, and to draw and present conclusions. – Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a systematic analysis process. - Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. – Put into practice elements of emotional intelligence in the adequate socio-emotional management of some situations in academic life, demonstrating self-control and objectivity in decision-making 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.)*

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.* – Defines notions and concepts specific to the chosen study track, in close relation to the particular characteristics of the designed electronic system and its functional blocks. – Adequately describes the design and analysis techniques used for the system's development. – Understands and describes the phenomena involved in the system blocks' functionality and their impact at the system level. – Lists the most important stages of the involved technological processes and/or of the adopted software solutions, highlighting their limitations, advantages, disadvantages and applicability for the project. – Understands and adequately describes the stages of project development in accordance with the organization, requirements, and workflow used in industry.

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 in a given context, being able to adequately describe different theoretical and practical aspects related to the chosen study track. – Uses and justifies concepts and principles specific tot the chosen study track in order to adequately approach and solve problems. – Obtains experimental verification for identified solutions for the project tasks. – Correctly draws conclusions regarding obtained experimental results. – Explains and justifies the reasoning and methods used to solve problems.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* – Adequately selects and analyzes research sources. – Respects the principles of academic integrity and ethics, correctly using and citing references. – Demonstrates openness in new learning contexts. – Shows good team spirit when interacting with peers and teaching staff during teaching activities. – Demonstrates self-governance in organizing the learning process and problem solving. – Realizes the value of their own contribution to the field of engineering in identifying viable solutions for social and economic problems. – Identifies and analyzes business opportunities for using the knowledge gained in the chosen study track. – Demonstrates management abilities for real-life situations (e.g., adequate time management for the learning process).

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 being mainly the expository method and the problematization method, used head-on. The video projector is used, covering the communication and demonstration function, as well as interactive means, based on questions and answers and student feedback.
– In the teaching activity, students are guided in the analysis and design of the component blocks of the IoT system.
- Lectures will be used in the teaching activity, based on Power Point presentations or different videos that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.
– Presentations use images and diagrams so that the information presented is easy to understand and assimilate.
– This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.
– The practice of active listening and assertive communication skills, as well as feedback construction mechanisms, will be taken into account, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.
– The complete package of materials is available in electronic format on the faculty's Moodle platform

10. Contents

COURSE

Chapter	Content	No. hours
1	D/A and A/D converters and their role in sensor-based applications.	9
2	General concepts of "Internet-of-Things" type systems: Evolution of non-electrical quantity measurement systems.	3
3	Classification of translators a. Description of the main types of transducers. b. The equivalent electrical circuit.	12
4	Unbalanced Wheatstone bridges – ¼. ½ and full bridge rectifier examples	6
5	The characteristics of non-electrical measurement systems. Parasitic elements affecting measurements.	3
6	Measurement methodologies/techniques. (Auto)-Calibration. Precision, sensitivity, linearity, resolution. Systematic errors and random errors. Dynamic features.	6
7	The operational amplifier as a fundamental block for signal conditioning circuits a. Offset voltage reduction techniques. Amplifiers with switched capacities. The amplifier with modulation-demodulation. b. Differential and instrumentation amplifiers. c. Load amplifiers. d. Isolation amplifiers. e. Peak detectors, average value and effective. Phase sensitive detectors.	3
	Total:	42

Bibliography:

1. M. Enachescu, Senzori si circuite de conditionare a semnalelor, suport de curs electronic pe platforma Moodle a facultății de ETTI: https://curs.upb.ro/2021/course/view.php?id=9872
2. R.J. Baker, CMOS: Circuit Design, Layout, and Simulation, 4th Ed., IEEE Press, Wiley, 2019.
3. Behzad Razavi, „Design of Analog CMOS Integrated Circuits”, McGraw-Hill, Inc., 2017.
4. Bodea, M., I. Mihut, L. Turic, V. Tiponut, Aparate Electronice pentru Masurare si Control, Editura Didactica si Pedagogica, 1985
5. R.C. M. Meijer, “Smart Sensor Systems”, John Wiley & Sons, 2008

LABORATORY

Crt. no.	Content	No. hours
1	Temperature sensors and their applications	2
2	Capacitive sensors and strain gauges. Applications	2
3	Ultrasound sensors and their applications. Infrared transmition.	2
4	Low pass filters.	2
5	High pass filters and pass filters.	2
6	Digital temperature and distance sensors. Microcontroller based applications.	2
7	Laboratory Evaluation.	0
	Total:	14

Bibliography:

1. M. Enachescu, Senzori si circuite de conditionare a semnalelor, suport de laborator electronic pe platforma Moodle a facultății de ETTI: https://curs.upb.ro/2021/course/view.php?id=9872
2. http://wiki.dcae.pub.ro/index.php/Circuite_Integrate_%C8%99i_Sisteme_de_Achizi%C8%9Bie

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Midterm	Written	30
	Final exam	Written/Oral	40
11.5 Seminary/laboratory/project	Measurement summaries	Written	9
	Tests	Written	6
	Final test	Written/Practical Evaluation	15
11.6 Passing conditions			
Obtaining minimum 50% of the final exam score and minimum 50% from the laboratory activities.			

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 content of the discipline and the skills acquired correspond to the expectations of professional organizations (e.g. ARIES) and companies where students do internships and/or work, as well as national quality assurance bodies (ARACIS).
- Representative employers: medium and small national and international design centers for the design and implementation of hybrid sensor and signal conditioning systems.
- In this way, the graduates are provided with adequate skills with the needs of the current qualifications and a modern, quality and competitive scientific and technical training, which will allow them to be employed quickly after graduation, the course being perfectly framed in the policy of the Politehnica University of Bucharest, both from the point of view of the content and structure, as well as in terms of skills and international openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
09.09.2022	S.l./Lect. Dr. Marius Enachescu	

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

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Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea