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	Advanced Microelectronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Senzori pentru autovehicule Automotive Sensors			
2.2 Course Lecturer				Prof. Dr. Claudius DAN			
2.3 Instructor for practical activities				NA			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M2.O.04-10		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	0
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	0
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.					45
Tutoring					0
Examinations					2
Other activities (if any):					0

3.7 Total hours of individual study	47.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Graduation of the following courses: • Physics • Electronic materials • IC Processes • Basic electronic devices
4.2 Results of learning	Following knowledge is required: • Basic semiconductor device operation • Basic solid state • Automotive electronics design methodologies

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

5.1 Course	• Course classes will take place in a classron having videoprojector and computer. • For synchronous broadcasting/recording, high speed Internet connection is necessary
5.2 Seminary/ Laboratory/Project	NA

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 topic is studied in the Electronics, Telecommunication and Information Technology domain / Advanced Microelectronics Master Program and aims to present and analyze main aspects dedicated sensors for the automotive industry and automotive electronics specifications and design methodology for signal conditioning for these sensors.

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 the graduate has basic and advanced **knowledge** in the domain of automotive industry and automotive electronics. **Understands** the operating principle of the main types of the automotive sensors, theirs resources and limitations; **Interpret** the specification of the main types of the automotive sensors; **Choose** the suitable sensor type for a particular application; **Understand** and **formulates the specification** of the electronic system for sensors' signal processing; **Correlates knowledge** **Applies** knowledge **Applies** standard methods and instruments specific to the domain in order to **evaluate** and **diagnose** the status of the task to be performed and, based on the conclusions identified/reported **identifies** solutions. **Analizes and arguments** coherently and correctly the base knowledge application context using key concepts and specific methodology. **Oral and written communication in Romanian language**: uses appropriate scientific vocabulary in order to effectively communicate. **Oral and written communication in English language**: demonstrates specific vocabulary mastering.

Transversal (General) Competences	**Works in a team and efficiently communicates**, coordinating her/his efforts to others efforts in order to solve **medium size/complexity issues**. **Autonomy and critical thinking**: ability to think using appropriate scientific terms, to independently search and analyze data and to draw and present conclusions / identify solutions. **Analysis and synthesis ability**: synthetically presents acquired knowledge via systematic analysis. **Follows academic ethics**: in the documentation activity properly cites the bibliographical sources.

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.* • **Understands** the specifics of automotive electronics from both system level and component level; • **Interprets** the specification of an automotive electronic system and its component; • **Applies** the automotive electronics system design methodology • **Defines** domain specific terms. • **Describes/classifies** terms/processes/phenomena/structures. • **Points out relations and consequences**.
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 specific context. • **Uses specific principles, based on arguments, in order to effectively design chips and achieve the "first-time-success" goal**. • **Works** productively **in a team**. • **Elaborates scientific texts**. • **Experimentally verifies identified solutions**. • **Solves** practical applications. • Correctly **interprets** de causality connections. • **Analyses and compares different design styles**. • **Identifies solutions** and **elaborates** solution plans/projects. • **Draws conclusions from the experiments**. • **Arguments identified** solutions

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • **Selects** appropriate bibliography and analyses it. • **Follows academic ethics**, correctly citing sources. • **Proves receptivity** for new learning contexts. • **Collaborates** with her/his colleagues and teachers during the didactic process. • **Proves autonomy** in setting up teaching/solving problem context/. • **Proves social responsibility** by actively involving in student social live/implication in academic community events. • **Promotes/contributes to social** live improvement by new solutions in her/his specialization domain • **Is aware of her/his contribution in engineering field**, in identifying viable/sustainable solutions to solve socio-economic issues (social responsibility). • **Applies ethical principles/professional deontology** in analysis of environmental effects of proposed technological solutions. • **Analyzes and exploits business opportunities** /entrepreneurial development in the domain. • **Proves management abilities** in 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.)*

Based on students' study characteristics analysis and their specific needs, the teaching process will explore both exposing methods (lecture, exposition) and interactive dialogs, based pe on discovery teaching methods that are facilitated by direct reality exploration (experiment, demonstration, modelling), and also action based methods like exercises, practical activities and problem solving.

In the teaching activity exposition will be used based on both Power-Point and different recordings that will be available to the students. Each class will debut by reviewing previous chapters pointing out notions in the last previous class.

Presentations use images and graphs in order to facilitate notions understanding and assimilation.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Automotive Trends & Market (Automotive Sensor Market, Automotive trends, Safety, Body, Power train, Sensor environment)	2
2	Temperature Sensors (Diode, ΔVbe Temperature Sensor, Bandgap Reference, Thermocouples)	2
3	Acceleration Sensors (Accelerometer, Tire Pressure Monitoring, Accelerometers for airbags)	4
4	Gyroscopes Sensors (Coriolis Force, Accelerometer as gyroscope, Gyroscope example)	3
5	Pressure Sensors (Manifold Air Pressure, Deflecting diaphragm, Capacitive pressure sensor, Tire Pressure Monitoring)	3

6	Magnetics - Hall Sensors (Rotary speed and position sensors, Variable Reluctance - Faraday‘s Law, Hall Effect, Chopped Hall Plate, Hall Switches, Automotive Applications, Linear Hall Sensor, Rotary Application)	3
7	Magnetoresistance (AMR effect, GMR -- Giant Magneto Resistive Effect)	3
8	Radar (Maxwell Equations, Antennas, Pulse Radar, CW Radar, FMCW Radar Principle)	2
9	Cameras (Photodiode, Camera array, Fill factor, Processing)	2
10	Chemical Sensors (Lambda sensor, Metal oxide sensors, Infrared Gas Sensors, GASFET)	2
11	Electric Field Sensors (Measurement Principle, Applications)	2
	Total:	28

Bibliography:

1. HAMMERSCHMIDT Ditk, Handouts of the AEIV Course, annually updated, https://curs.upb.ro/2021/mod/folder/view.php?id=240285

Automotive:

2. “Autoelektrik, Autoelektronik”, Bosch, ISBN-3-528-03872-1

Devices, Temperature:

3. S.M. Sze, “Semiconductor Devices”, Wiley, ISBN 0-471-83704-0

MEMS:

4. M.-H. Bao, “Handbook of sensors and Actuators – Pressure Sensors, Accelerometers and Gyroscopes”, Volume 8, Elsevier, ISBN 0-444-50558-X

Hall:

5. Ed Ramsden, “Hall Effect Sensors”, Advanstar, ISBN 0-929870-58-1

Chemical:

6. Martin Sinner-Hettenbach; “SnO2(110) and Nano-SnO2: Characterization by Surface Analytical Techniques”; Dissertationsschrift; Eberhard-Karls-Universität Tübingen; 2000
7. Kosmas Galatsis, Wojtek Wlodarski; “Car Cabin Air Quality Sensors and Systems”; Encyclopedia of Sensors – EOS; www.aspbs.com/eos

Circuits:

8. R.J. Baker, “CMOS Circuit Design, Layout and Simulation”, Wiley, ISBN 0-471-70055-X

EMC:

9. M.I. Montrose, E.M. Nakauchi, “Testing for EMC Compliance”, Wiley, ISBN 0-471-43308-X

Bibliography:

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Fundamental theoretical notions knowledge	Final grid type written exam	30
	Specific problems solving solutions for each integrated circuit design stage.	Final grid type written exam	30
	Design methodologies and stages mastering,	Final grid type written exam	40

11.5 Seminary/laboratory/project			
11.6 Passing conditions			
Obtaining minimum 50% of the total 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)

- Via the teaching activities, students get acquinted with automotive industry problems and solutions.
- In the course development both literature described aspects, knowledge and phenomena and own contributions published or acquired in industrial activities were used.
- The course has similar content to courses taught in: Lodz University of Technology, Poland, THE UNIVERSITY of EDINBURGH, Newcastle, Great Britain etc.
- The course was developed in cooperation with Infineon Technologies, Romania. Dr. Hammerschmidt is senior researcher in Infineon Villach, Austria.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Claudius DAN	

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