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	Micro and Nanoelectronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Proiectarea circuitelor integrate analogice Analog Integrated Crcuits Design			
2.2 Course Lecturer				Colaborator Dr. Cornel Stanescu			
2.3 Instructor for practical activities				Colaborator Dr. Cornel Stanescu			
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.05-34		2.10 Tipul de notare	Nota

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

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 Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					20
Tutoring					0
Examinations					13
Other activities (if any):					0

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)

4.1 Curriculum	Fundamental Courses of Electronic Devices and Integrated Analog Circuits.
4.2 Results of learning	General knowledge of physics, electronic devices and electrical measurements.

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

5.1 Course	The course will take place in a room equipped with a video projector or on the MSTeams platform
5.2 Seminary/ Laboratory/Project	The project will take place in a specific room, which must include: computers, Internet connection, SPICE electronic circuit simulator or MSTeams platform, etc, students with computers with a SPICE simulator installed.

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)*

Acquiring the principles of analysis of analog integrated circuits and the necessary design knowledge in the industry of analog IC design and research.

- Architectures, operation analysis, advantages and limitations of CMOS amplifier performance.

- Types of operational amplifiers : „rail-to-rail” in CMOS technology, CMOS precision operational amplifier with chopper; high voltage CMOS precision operational amplifier with chopper;

- Development directions of circuit techniques in CMOS precision operational amplifiers.

- CMOS amplifiers, layout and encapsulation.

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	C1s. Use of fundamental elements relating to electronic devices, circuits, systems, instrumentation and technology C2's. Design, simulation and testing of devices, integrated circuits and micro and nanoelectronic systems with modern software tools C3's. Modeling and processing of integrated devices and circuits using advanced technologies C4's. Design, simulation and testing of optoelectronic devices, circuits and systems with modern micro and nanoelectronic software tools and technologies
Transversal (General) Competences	CT1 Adaptation to new technologies, professional and personal development, through continuous training using printed documentation sources, specialized software and electronic resources in Romanian and at least, in a language of international circulation.

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.* List the parameters of the integrated circuits Defines the characteristic elements of integrated circuits Describe/classify model parameters Highlights the peculiarities of special constructive solutions
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 about the constructive types of integrated circuits. Arguably uses specific principles in order to preserve or neglect some model parameters. Work productively in a team to perform laboratory work. Elaborates a scientific text in the drafting of laboratory reports Experimentally check the design solutions within the bleach. Solves practical applications within the laboratory, processing measured data sets. Adequately interprets causal relationships between extracted values. Analyzes and compares the measured values. Identify measurement solutions in the laboratory. Conclusions on the experiments carried out. Arguing the solutions identified .
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Select appropriate bibliographic sources and analyze them. Respect the principles of academic ethics, correctly quoting the used bibliographic sources. Demonstrate responsiveness for new learning contexts. Demonstrates collaboration with other colleagues and teachers in carrying out teaching activities Demonstrates autonomy in organizing the learning situation/context or problem-solving situation Promotes/contributes through new solutions, related to the specialty field. Awareness of the value of its contribution to the field of engineering in identifying viable/sustainable solutions Apply ethical principles

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.)*

Building on the analysis of students' learning characteristics and their specific needs, the teaching process will explore teaching methods both expository (lecture, exposure) and conversational-interactive, based on learning by discovery models facilitated by direct and indirect exploration of reality (experiment, demonstration, modeling), but also on action-based methods such as exercise, exercise, and, practical activities and problem solving.

Lectures will be used in the teaching activity, based on PowerPoint presentations or different Internet pages that will be made available to students. Each course will start with the recapitulation of the chapters already covered, with an emphasis on the notions taken at the last course.

The presentations use images and schemes so that the information presented is easily understood and assimilated.

This discipline covers information and practical activities designed to support students in their learning efforts and to develop optimal relationships of collaboration and communication in a climate conducive to learning through discovery.

The practice of active listening and assertive communication skills, as well as feedback building mechanisms, will be considered, as ways of behavioral regulation in various situations and of adapting the pedagogical approach to the learning needs of the students.

The ability to work in teams to solve different learning tasks will be practiced.

The attention of students will be checked by rapid tests (quizz) during or at the end of the course at certain courses.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	1. Introduction 1.1 "s. Course theme 1.2. Stages of integrated circuit design	2
2	2.Analog design in the context of digitalization, levels of abstraction. The operational amplifier concept. History: the first operational amplifiers in bipolar technology; performance scheme and analysis; technological limitations. The first operational amplifiers in CMOS technology; comparison with bipolar; technological limitations. The first precision operational amplifiers in bipolar technology; the scheme and performance analysis.	4
3	3.Advanced notions about operational amplifiers with one or more floors, amplification, input domain limitations, tracking speed, power voltage rejection, noise in operational amplifiers, linearization techniques. Reaction, floors with one or more reaction transistors, stabilizer and oscillator as reaction circuits.	2
4	4.CMOS manufacturing technologies, platelets, lithography, oxidation, impurity, deposition and corroding, latch-up. Layout and encapsulation.	4
5	5.Operational amplifiers of type „rail-to-rail” in CMOS technology; advantages and limits of performance	4
6	6.CMOS precision operational amplifier concept with chopper; basic architecture and theoretical analysis of operation.	4
7	7.Description and detailed analysis of a low voltage CMOS operational amplifier with chopper.	4
8	8.High voltage CMOS precision amplifier with chopper; differences from low voltage. Development directions of circuit techniques in CMOS precision operational amplifiers.	2
9	9.Differentialstages ncluding constant-gm circuits; operating principle; performance; advantages and disadvantages.	2
	Total:	28

Bibliography:

C. Stanescu, https://curs.upb.ro/2023/enrol/index.php?id=9681 ,https://curs.upb.ro/2021/enrol/index.php?id=9195

C. Stanescu, „Proiectarea circuitelor integrate de precizie in tehnologii submicronice”, Manuscrisul scanat al notelor de curs, 2021.

C. Stanescu, C. Dinca, R. Iacob, "Symmetrical passive RC notch filter with two cutoff frequencies for ripple reduction in chopper offset-stabilized amplifiers”, p.215-218, CAS Proceedings 2014.

C. Stanescu, C. Dinca, R. Iacob, A. Sevcenco, “Optimizing Frequency Compensation in Chopper Offset-Stabilized Amplifiers With Symmetrical RC Notch Filters”, CAS Proceedings p.167-170 , 2015.

C. Stanescu, C. Dinca, D. McDonald, D. Paul, “A 24 V Chopper Offset-Stabilized Operational Amplifier with Symmetrical RC Notch Filters”, p.167-170, CAS Proceedings 2017.

C. Stanescu, C. Dinca, D. Paul, “A 5.5-V 7-MHz UGBW Dual Rail-to-Rail CMOS Op Amp with Enable Pin and Hi-Z Output Feature”, p.133-136, CAS Proceedings 2019.

A. Veselu, C. Stănescu, G. Brezeanu, “Low Current Constant-gm Technique for Rail-to-Rail Operational Amplifiers”, p.253 - 256, CAS Proceedings 2020.

C. Stanescu, C. Dinca, A. Veselu, R. A. Cojan, A. Sevcenco, V. Bricicaru, A. Croitoru, “A Dual Low Voltage Chopper Offset-Stabilized Operational Amplifier”, p.129-132, CAS Proceedings 2021.

C. Stanescu, C. Dinca, D. McDonald, D. Paul, “A 24 V Chopper Offset-Stabilized Operational Amplifier with Symmetrical RC Notch Filters having sub-10 µV offset and over-120dB CMRR”, ROMJIST, Volume 20, Number 4, p.301-312, 2017.

A. Veselu, C. Stănescu, G. Brezeanu, “New Constant-gm circuit for precision chopper offset-stabilized operational amplifiers”, ROMJIST,Volume 24, Number 2, p.182-200, 2021.

C. Stanescu, US Patent No.: 9,391,571/July 12, 2016 – “Chopper-stabilized amplifier and method therefor”.

C. Stanescu, R. Puscasu, US Patent No.: 10,411,664/September 10, 2019 - “Chopper-stabilized amplifier with analog-driven level shifter”.

PROJECT

Crt. no.	Content	No. hours
1	Description and calculation of the electrical parameters of integrated CMOS circuits of operational amplifiers with chopper	8
2	Theoretical calculation of some electrical parameters	6
	Total:	14

Bibliography:

C. Stanescu, https://curs.upb.ro/2023/enrol/index.php?id=9681
https://curs.upb.ro/2021/enrol/index.php?id=9195
C. Stanescu, „Proiectarea circuitelor integrate de precizie in tehnologii submicronice”, Manuscrisul scanat al notelor de curs, 2021.
C. Stanescu, C. Dinca, R. Iacob, "Symmetrical passive RC notch filter with two cutoff frequencies for ripple reduction in chopper offset-stabilized amplifiers”, p.215-218, CAS Proceedings 2014.
C. Stanescu, C. Dinca, R. Iacob, A. Sevcenco, “Optimizing Frequency Compensation in Chopper Offset-Stabilized Amplifiers With Symmetrical RC Notch Filters”, CAS Proceedings p.167-170 , 2015.
C. Stanescu, C. Dinca, D. McDonald, D. Paul, “A 24 V Chopper Offset-Stabilized Operational Amplifier with Symmetrical RC Notch Filters”, p.167-170, CAS Proceedings 2017.
C. Stanescu, C. Dinca, D. Paul, “A 5.5-V 7-MHz UGBW Dual Rail-to-Rail CMOS Op Amp with Enable Pin and Hi-Z Output Feature”, p.133-136, CAS Proceedings 2019.
A. Veselu, C. Stănescu, G. Brezeanu, “Low Current Constant-gm Technique for Rail-to-Rail Operational Amplifiers”, p.253 - 256, CAS Proceedings 2020.
C. Stanescu, C. Dinca, A. Veselu, R. A. Cojan, A. Sevcenco, V. Bricicaru, A. Croitoru, “A Dual Low Voltage Chopper Offset-Stabilized Operational Amplifier”, p.129-132, CAS Proceedings 2021.
C. Stanescu, C. Dinca, D. McDonald, D. Paul, “A 24 V Chopper Offset-Stabilized Operational Amplifier with Symmetrical RC Notch Filters having sub-10 µV offset and over-120dB CMRR”, ROMJIST, Volume 20, Number 4, p.301-312, 2017.
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11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- knowledge of basic theoretical concepts related to the design of integrated circuits CMOS type precision operational amplifiers with chopper;	The evaluation grid test is done by written test examination of sustained verification at a fixed date during the exam session.	40%
	basic knowledge of calculating the electrical parameters of functional blocks in integrated CMOS circuits of precision chopper operational amplifiers type.	The evaluation is made by written test of verification sustained at a fixed date during the semester.	40%

11.5 Seminary/laboratory/project	- Description of the electrical parameters of integrated CMOS circuits with chopper operational amplifiers	The evaluation is done at a final deadline for the project delivery The degree of understanding of the significance of the obtained results is assessed	20%
11.6 Passing conditions			
Calculation of electrical parameters of functional blocks in integrated circuits CMOS type precision operational amplifiers with chopper. Obtaining 50% of the laboratory score in the semester time. Compliance with the UNSTPB regulation on promotion conditions.			

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 increasing complexity of electronic circuits and systems and the need to reduce costs and research-design-manufacture cycles have imposed the development of computer-aided simulation, design and optimization techniques, in the form of various software tools.

The discipline provides graduates with adequate skills with the needs of current qualifications and modern, quality and competitive scientific and technical training.

Thus, the graduates are ensured a modern scientific and technical training, quality and competitive, allowing them to be hired quickly after graduation, being perfectly framed in the university policy , both in terms of content and structure, and in terms of international skills and openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
01.09.2024	Colaborator Dr. Cornel Stanescu	Colaborator Dr. Cornel Stanescu

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