SYLLABUS

1. Program information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Communications
1.4 Field of study	Electronic engineering, telecommunications and information technologies
1.5 Cycle of study	Bachelor of Science
1.6 Study program / Qualification	Telecommunications technologies and systems / Engineer
1.7 Form of education	IF – full-time education

2. Course information

2.1 Course title	Systems with analog integrated circuits				Course code	30.00
2.2 Course coordinator	*Assoc. Prof. Marius Neag, PhD - Marius.Neag@bel.utcluj.ro*					
2.3 Seminar/ laboratory/ project/ practical activity coordinator	*Lecturer Raul Onet, PhD - Raul.Onet@bel.utcluj.ro*					
2.4 Year of study	III	2.5 Semester	1	2.6 Type of assessment		E
2.7 Course status	Formative category					DF
	Optionality					DOB

3. Estimated total time

3.1 Hours per week	5	of which:	3.2 Lecture	2	3.3 Seminar	0	3.3 Laboratory	2	3.3 Project	1	3.3 Practical training	0
3.4 Hours per semester	70	of which:	3.5 Lecture	28	3.6 Seminar	0	3.6 Laboratory	28	3.6 Project	14	3.3 Practical training	0

3.7 Time distribution (hours per semester) for individual study and assessment:	
(a) Assessment	5
(b) Study using textbook, course materials, bibliography, and notes	15
(c) Additional documentation in the library, on specialized electronic platforms, and in the field	5
(d) Preparation for seminars/laboratories, assignments, reports, portfolios and essays	28
(e) Tutoring	2
(f) Other activities	-
3.8 Total hours of individual study and assessment (sum of (3.7(a)...3.7(f))	55
3.9 Total hours per semester (3.4+3.8)	125
3.10 Number of credits	5.0

4. Prerequisites (where applicable)

4.1 curriculum	Fundamental Electronic Circuits, Analog Integrated Circuits
4.2 competencies	Good understanding of the operation and modeling of electronic devices such as diodes, BJT and MOS transistors. Good understanding of, and ability to use for circuit analysis, the operation and parameters of main analog building blocks: amplifying stages with one- and two-transistors, the differential pair, current mirrors, voltage references; general purpose OAs Working knowledge of circuit theory and signal theory Working knowledge of CAD tools employed in the analysis and design of analog circuits

5. Requirements (where applicable)

5.1. for the development of the lecture	Amphitheatre, Cluj-Napoca
5.2. for the development of the seminar/ laboratory/ project	Laboratories with standard electronic equipment, Cluj-Napoca

6. Specific competencies acquired

Professional competencies	C1. Use of the fundamental elements related to devices, circuits, systems, instrumentation and electronic technology C1.1 Description of the functioning of electronic devices and circuits and of the fundamental methods of measuring electrical parameters C1.2 Analysis of electronic circuits and systems of low/medium complexity, for the purpose of designing and measuring them C1.3 Diagnosis/troubleshooting of electronic circuits, equipment and systems C1.4 Use of electronic tools and specific methods to characterize and evaluate the performance of electronic circuits and systems C1.5 Design and implementation of electronic circuits of low/medium complexity using CAD-CAM technologies and standards in the field C2. Applying the basic methods for the acquisition and processing of signals C2.1 Temporal, spectral and statistical characterization of signals C2.2 Explaining and interpreting the methods of signal acquisition and processing C2.3 Use of simulation media for signal analysis and processing C2.4 Use of specific methods and tools for signal analysis C2.5 Design of basic functional blocks for digital signal processing with hardware and software implementation C4. Design, implementation and operation of data, voice, video and multimedia services. This is based on the understanding and the application of fundamental concepts in telecommunications and transmission of information. C4.1 Identification of the fundamental concepts regarding the transmission of information and analog and digital communications C4.2 Solving practical problems using general knowledge of multimedia techniques C4.3 Explanation and interpretation of the main requirements and specific approach techniques for data, voice, video, multimedia transmissions

	C4.4 Use of the main specific parameters in evaluations based on the concept of quality of service in communications C4.5 Development of simple communications services C4.6 Passing an examination regarding the main characteristics of the usual communications services C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications networks C5.1 Defining the principles of the main technologies for fixed and mobile telecommunications, through various transmission media C5.2 Explanation and interpretation of the technologies and of fundamental protocols for integrated fixed and mobile communications systems C5.3 Installation, configuration and exploiting of communications networks C5.4 Use of evaluation techniques and diagnostics for communications systems and equipment C5.5 Endowment with communications means of a location with a small/ medium degree of complexity C5.6 Solving an installation and maintenance problem for a communications system with low/medium complexity
Transversal competencie	

7. Expected learning outcomes

Knowledge	- The student/graduate describes, identifies and summarizes elementary concepts and methods related to electronic devices, circuits and instrumentation, as well as their application in concrete problems.
Skills	- The student/graduate uses fundamental methods for measuring electrical quantities and assesses electronic devices and circuits, as well as linear and digital integrated circuits of low/medium complexity. - The student/graduate designs, measures, evaluates performance, diagnoses and troubleshoots functional blocks composed of low/medium-complexity electronic devices and/or circuits.
Responsibility and autonomy	- The student/graduate carries out project management processes in electronics, telecommunications and information technologies, taking on different team roles and clearly and concisely describing the results, both orally and in writing.

8. Course objectives (based on the grid of specific competencies acquired)

8.1 General objective of the course	Develop students' competencies regarding the analysis, design, verification and characterization of a wide range of analog systems

	implemented with OAs, Gm-cells and application-specific integrated circuits (ASICs).
8.2 Specific objectives	1. Understand the operation and main limitations of general-purpose and specialized OAs and Gm-cells and be able to estimate the effects those limitations have on circuits implemented with OAs and Gm-cells 2. Understand the operation of, and be able to assess the circuit function and main parameters of a wide range of analog systems based on OAs and Gm-cells 3. Understand the operation and main features resulted from datasheet information of application-specific integrated circuits (ASICs); develop skills and abilities required for analyzing circuits based on ASICs, use them properly and develop new applications with them. 4. Acquire the knowledge and skills necessary for systematic analysis and design of systems implemented with OAs, Gm-cells and ASICs Develop the skills and abilities necessary to design, implement and make use of testbenches for functional verification and characterization of analog systems based on OAs, Gm-cells and ASICs

9. Contents

9.1 Lecture	**No. of hours**	**Teaching methods**	**Remarks**
Overview: objectives, content, methodology. General-purpose voltage-voltage operational amplifier (OA): principle of operation, limitations associated with DC operation and corresponding parameters; effects on basic circuits implemented with OAs. Methods for minimizing/compensating the effects of DC non-idealities	2	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation	Use of PowerPoint presentation, projector, blackboard
General-purpose voltage-voltage operational amplifier (OA): limitations associated with small- and large-signal operation; the corresponding parameters and models; effects on basic circuits implemented with OAs.	2		
Noise in analog circuits: types of electrical noise, modeling and analysis methods. Noise models for passive and active devices.	2		
Voltage references and linear voltage regulators: function and features; key parameters; main ideas for circuit implementation	2		
Current-Mode active devices - the Current-Feedback Operational Amplifier (CFB-OA) and the linear transconductor (Gm cell): operation; internal structure; modeling; parameters; main applications; comparison with traditional OA.	2		
Continuous-time filters: main types, topologies and synthesis methods; implementation of 1st and 2nd order sections by using voltage- and current-mode active devices, particularly the AO-RC and Gm-C techniques	2		

9.1 Lecture	No. of hours	Teaching methods	Remarks
Controlled-gain amplifiers implemented with voltage- and current-mode active devices	2		
Precision and instrumentation amplifiers: function & features, parameters; classical implementation solutions in voltage- and current mode.	2		
Circuits with non-linear transfer characteristics: precision rectifiers; peak detectors; sample-and-hold amplifiers.	2		
Harmonic Oscillators	2		
Integrated voltage comparators: structure and applications. Internal structures; main limitations and corresponding parameters. Circuit implementation of: summing and differential comparators; window comparators; Schmitt triggers.	2		
Signal generators based on bi-stable circuits and on harmonic oscillators: main features and implementation techniques. Examples of OA-based harmonic oscillators, triangular & rectangular – wave and saw-tooth wave generators.	2		
Analog Computational Circuits (Multipliers, Dividers, Log amp, etc.) - main features and implementation techniques; examples of, and applications with, integrated analog multipliers.	2		
Frequency synthesizers based on PLL circuits: principle of operation, main parameters, examples of circuit implementation for the Voltage-Controlled Oscillator	2		

Bibliography

1. P. R. Gray, R. G. Meyer, *Analysis and Design of Analog Integrated Circuits,* John Wiley and Sons, 2003. 2009
2. S. Franco – Design with Operational Amplifiers and Analog Integrated Circuits, McGraw-Hill, 1998, 2001, 2014
3. W. Jung (Ed.) - Op Amp Applications Handbook, Springer, 2005
4. D. Johns, K. Martin - Analog Integrated Circuit Design, John Wiley & Sons, 1997
5. B. Razavi - *Design of CMOS Analog Integrated Circuits*, McGraw-Hill, 2001
6. W. Sansen – Analog *Design Essentials*, Springer, 2006
7. R. Coughlin, F.F. Driscoll – Operational Amplifiers and Linear Integrated Circuits, Prentice Hall, 2001
8. M. Neag, *Sisteme cu Circuite Integrate Analogice*, Mediamira, 2008
9. M. Neag, C. Pleșa, M. Purcar, Circuite integrate pentru managementul puterii proiectate cu simulatoare electro-termice, Editura UTPress Cluj-Napoca, 2022, ISBN 978-606-737-574-9
10. M. Neag, I. Kovacs, Integer-N Frequency Synthesizers - An IC Designer's Guide, Editura UTPress Cluj-Napoca, 2022, ISBN 978-606-737-573-2

On – line references

1. M. Neag, Systems with Analog IC – lecture notes and presentations, posted on the course site

9.2 Laboratory /project	No. of hours	Teaching methods	Remarks
9.2.1 Laboratory classes		Didactic and experimental proof, didactic exercise, team work	Use of laboratory instrumentation, experimental boards, computers, blackboard
Introduction: presentation of lab equipment and organization. Basic techniques for laboratory characterization of analog circuits and systems	2		
Limitations and parameters of general-purpose OAs: DC and large-signal operation	2		
Noise in analog circuits: noise analysis and methods for reducing noise impact on OA-based circuits.	2		
Effects of OA limitations on OA-based linear circuits; methods for reducing the impact on the overall circuit performance	2		
Voltage references and linear voltage regulators	2		
Linear transconductors: parameters and applications.	2		
Continuous-time filters based on first- and second-order sections implemented by using the AO-RC and Gm-C techniques	2		
Precision and Controlled-gain amplifiers.	2		
Instrumentation Amplifiers.	2		
Precision half- and full-wave rectifiers; peak detectors; sample & hold	2		
Voltage comparators implemented with general-purpose OAs and with integrated comparators	2		
Signal generators based on bi-stable circuits and on harmonic oscillators.	2		
Analog Multipliers and applications	2		
Voltage-to-frequency converters for frequency synthesizers based on PLL circuits.	2		
9.2.2 Project	**No. of hours**	**Teaching methods**	**Remarks**
Project definition and design requirements. Role and main parameters of the functional blocks within an analog Front-End for sensors. Project plan. Design methodology, deliverables, technical documentation	2	Didactic and experimental proof, didactic exercise, computers, blackboar	Use of laboratory instrumentation, experimental boards, computers, blackboard, written and oral test for progress assessment
Main limitations of general-purpose OAs and corresponding parameters. Effects of OA nonidealities on voltage-voltage and current-voltage amplifiers implemented with OAs. Methods for minimizing and compensating for OA nonidealities in OA-based linear circuits	2		
Controlled-gain amplifiers implemented with OAs: systematic analysis and sizing methodologies Design examples for OA-based controlled-gain amplifiers	2		
Design examples for Instrumentation Amplifiers implemented with OAs and specialized ICs	2		
Continuous-time filters implemented with OAs: systematic analysis and sizing methodologies	2		

9.2 Laboratory /project	No. of hours	Teaching methods	Remarks
Design examples for continuous-time filters implemented with OAs.			
Precision rectifiers and peak detectors implemented with OAs: systematic analysis and sizing methodologies Design examples for precision rectifiers and peak detectors implemented with OAs.	2		
Verification and optimization of the entire Analog Front-End Characterization of the entire AFE; technical documentation Project completion and evaluation	2		

Bibliography

1. M. Neag, A. Fazakas, Circuite Integrate Analogice, Casa Cărţii de Ştiinţă, 1999
2. L. Festila, N. Pop, S. Hintea, M. Neag - Circuite integrate analogice. Culegere de probleme, Lito UTCN,
3. T. Danila, N. Cupcea – Amplificatoare Operaționale – Aplicații, probleme rezolvate, Teora, 1994
4. S. Franco – Analog Circuit Design: Discrete & Integrated, McGraw-Hill, 2014
5. W. Jung (Ed.) - Op Amp Applications Handbook, Springer, 2005
6. R. Coughlin, F. Driscoll – Operational Amplifiers and Linear Integrated Circuits, Pretice Hall, 2001

On – line references

M. Neag, R. Onet - Systems with Analog IC – Design Guide, material posted on course's site

10. Alignment of the course contents with the expectations of the epistemic community, professional associations, and representative employers in the field related to the program

The course content and the teaching-learning-assessment methods are aligned with the current requirements of the Electronics, Telecommunications, and Information Technology Engineering field, considering the expectations of the academic and professional community, representative employers, as well as the national quality assurance standards in higher education. The course helps prepare students in line with employer expectations and the quality requirements set for engineering study programs.

11. Assessment

Activity type	11.1 Assessment criteria	11.2 Assessment methods (and type of assessment: continuous/ summative)	11.3 Weight in final grade
11.4 Lecture	The level of acquired theoretical knowledge and skills in analysis and design of analog integrated circuits	- Summative evaluation exam (theory and problems): Oral and/or written Face-to-face and/or on-line	- E, max 10 pts. 70%
11.5 Seminar/ Laboratory/ Project /Practical activity	The level of acquired practical abilities and design of functional blocks with analog ICs	- Continuous formative evaluation through written or oral tests during project classes and - Individual design project (common thematic but individualized requirements and design conditions (P)	- P, max. 10 pts. 30%

		- Homework (problem solving) and evaluation of lab reports (L)	-L , pass/fail

11.6 Minimum performance standard

• Active attendance of all lectures, whether on-site or on-line; skipping a lecture should be compensated by supplemental individual study of teaching materials, with verifiable results
• Attendance of, and active involvement in, all laboratory classes, resulting in fulfillment of all lab assignments + homework fully and accurately completed
• Obtain an average mark of 5 (out of 10) for each test taken during project classes
• Attendance of, and active involvement in, all project classes, resulting in meeting at least the minimum requirements: complete schematics; stable OP, circuit function realized; main parameters (such as gain, bandwidth, attenuation) within 20% of required values
• Get at least 5 points (out of 10) at the exam
• If all requirements described above are met, the final mark is computed by using the formula:

$$Mark = 0.7 * E + 0.3 * P$$

Completion date:	**Course coordinators**	**teaching rank, title First name LAST NAME**	**Signature**
23.06.2026	Lecture	Assoc. Prof. Marius Neag, PhD Eng.	
	Applications	Lecturer Raul Oneț, PhD Eng.	

Approval of the Head of the Department coordinating the course, only if this differs from the department organizing the study program	Head of the Bases of Electronics Department Prof. Sorin HINTEA, Ph.D.

Date of approval by the Council of the Department of Communications 26.06.2026	Head of the Communications Department Prof. Virgil DOBROTĂ, Ph.D.
Date of approval by the Council of the Faculty of Electronics, Telecommunications and Information Technology 30.06.2026	Dean, Prof. Ovidiu-Aurel POP, Ph.D.