SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and information Technology
1.3 Department	Bases of Electronics
1.4 Field of study	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Telecommunications Technologies and Systems/ Engineer Applied Electronics/Engineer
1.7 Form of education	Full time
1.8 Subject code	TST-E26.00/EA-E26.00

2. Data about the subject

2.1 Subject name	Analog Integrated Circuits						
2.2 Subject area	Theoretical area Methodological area Analytic area						
2.3 Course responsible	Assist. Prof. Gabor CSIPKES, Ph.D.- gabor.csipkes@bel.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Assist. Prof. Gabor CSIPKES, Ph.D.- gabor.csipkes@bel.utcluj.ro						
2.5 Year of study	2	2.6 Semester	4	2.7 Assessment	E	2.8 Subject category	DD/DI

3. Estimated total time

3.1 Number of hours per week	4	of which: 3.2 course	2	3.3 seminar / laboratory	2
3.4 To Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar / laboratory	28
Distribution of time					hours
Manual, lecture material and notes, bibliography					14
Supplementary study in the library, online specialized platforms and in the field					7
Preparation for seminars / laboratories, homework, reports, portfolios and essays					14
Tutoring					6
Exams and tests					3
Other activities:					

3.7 Total hours of individual study	44
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	Passive components and electronic circuits, Electronic devices Electrical circuit theory, Signal theory, Fundamental electronic circuits
4.2 competence	Fundamental skills in computer aided design of electronic circuits

5. Requirements (where appropriate)

5.1. for the course	Board and beamer
5.2. for the seminars / laboratories / projects	Board and computer

6. Specific competences

Professional competences	C1. Use of the fundamental elements related to devices, circuits, systems, instrumentation and electronic technology C2. Applying the basic methods for the acquisition and processing of signals
Transversal competences	N/A

7. Discipline objectives (as results from the key competences gained)

7.1 General objective	Develop skills in analysis and design of fundamental analog building blocks
7.2 Specific objectives	1. Accummulate the theoretical bases of bipolar and CMOS operational amplifier internal structure and performance indicators. 2. Obtain skills required to design an operational amplifier for any given set of specifications.

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
1. Integrated semiconductor devices. MOSFET-s and bipolar junction transistors	Presentations, discussions, interactive teaching style	
2. Small signal device models and parameters. Biasing techniques. Latch-up in CMOS technologies.		
3. Current sources and sinks. Advanced current source architecures. Increasing the output resistance and decreasing the minimum required bias voltage.		
4. Bipolar and CMOS current mirrors. Parameters. Methods to reduce gain errors.		
5. Integrated voltage and current references. Sensitivity and temperature coefficient. Vth/R, Vbe/R, Widlar and PTAT references.		
6. References with supply voltage and temperature compensation (bootstrap, band gap)		
7. Elementary bipolar and CMOS voltage amplifiers. Principles of operation. Frequency response. Performance enhancements.		
8. Improved elementary amplifier structures. Asymmetrical, symmetrical and folded cascode amplifiers. Operating principles. Frequency response.		
9. Differential amplifiers. Fundamental configurations. Parameters.		

Frequency response.		
10. Linearisation of the fundamental differential amplifier. Emitter – source degeneration and the effect of negative feedback.		
11. The fundamental opamp with Miller compensation. Principles of operation. Small signal model. Frequency response. Design algorithm based on a given set of specification.		
12. The cascode and folded cascode opamps. Comparison with the Miller compensated opamp. Small signal models. Frequency responses. The design algorithm.		
13. Transconductance amplifiers. Fundamental linear OTA arcitectures. Applications.		
14. Stability of feedback amplifiers. Stability criteria based on the loop gain. Stability indicators. Stability conditions for the amplifier on the forward signal path.		
8.2 Seminar / laboratory	Teaching methods	Notes
Seminar	Presentation and problem solving, learning through cooperation, explanation and demonstration	
1. Current sources and sinks.		
2. Current mirrors.		
3. Voltage and current references.		
4. Elementary and differential voltage amplifier stages.		
5. Opamp internal sructures. Analysis.		
6. Opamp design algorithms.		
7. Review		
Laboratory	Presentation and applications, learning by experimentation, simulation exercises, computer aided learning	
1. Transistors – biasing, characteristics, operating regions, setting the operating point.		
2. Design and analysis of electronic current sources.		
3. Current mirrors.		
4. Voltage and current references.		
5. Elementary voltage amplifier stages.		
6. Differential amplifiers.		
7. Miller compensated and folded cascode opamp architectures.		

Bibliography

1. D. Csipkes – Circuite Integrate Analogice. Circuite fundamentale – Casa Cărții de Știință, 2007;
2. D. Csipkes, G. Csipkes – Elemente constructive utilizate în proiectarea circuitelor analogice complexe – Casa Cărții de Știință, 2004;
3. L. Festila – Circuite integrate analogice 1 – Casa Cărții de Știință, 1997;
4. L. Festila – Circuite integrate analogice 2 – Casa Cărții de Știință, 1999;
5. P.E. Allen, D. Holberg – CMOS Analog Circuit Design, Second Edition, Oxford Press, 2002;
6. D. Csipkes, G. Csipkes – Fundamental Analog Circuits. Practical Simulation Exercises – UTPres, 2004;
7. Robert Groza, Gabor Csipkes, Doris Csipkes,Circuite integrate analogice. Indrumator de laborator, Editura U.T.PRESS, Cluj-Napoca, 2015.

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The discipline content and the acquired skills are in agreement with the expectations of the professional Competences acquired will be used in the following COR occupations (Electronics Engineer; Telecommunications Engineer; Electronics Design Engineer; System and Computer Design Engineer; Communications Design Engineer) or in the new occupations proposed to be included in COR (Sale Support Engineer; Multimedia Applications Developer; Network Engineer; Communications Systems Test Engineer; Project Manager; Traffic Engineer; Communications Systems Consultant).

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Problem solving	written exam	80%
10.5 Seminar/ Laboratory	Practical simulation exercises	practical test	20%
10.6 Minimum standard of performance			

- ✓ Passing mark at the exam (≥4.5)
- ✓ laboratory presences,
- ✓ final mark ≥5

Date of filling in:	Responsible	Title First name SURNAME	Signature
29.09.2020	Course	Assist. Prof. Gabor CSIPKES, Ph.D.	
	Applications	Assist. Prof. Gabor CSIPKES, Ph.D.	

Date of approval in the Department of Communications 30.09.2020	Head of Communications Department Prof. Virgil DOBROTA, Ph.D.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology 30.09.2020	Dean Prof. Gabriel OLTEAN, Ph.D.