SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Bases of Electronics
1.4	Field of study	Electronics and Telecommunications Engineering
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					Analog Circuit Design					
2.3	Course responsible/lecturer					Assistant Professor Gabor Csipkes, PhD					
2.4	Teachers in charge of applications					Assistant Professor Gabor Csipkes, PhD					
2.5	Year of study	II	2.6	Semester	2	2.7	Assessment	Exam	2.8	Subject category	DD/DI

3. Estimated total time

Year/ Sem.	Subject name	No. of weeks	Course [hours/week]	Applications [hours/week]			Course [hours/sem.]	Applications [hours/sem.]			Indiv. study	TOTAL	Credits
				S	L	P		S	L	P			
II / 2	Analog Integrated Circuits	14	2	1	1		28	14	14		44	100	4

3.1	Number of hours per week	4	3.2	of which, course	2	3.3	applications	2
3.4	Total hours in the curriculum	56	3.5	of which, course	28	3.6	applications	28

Individual study	Hours
Manual, lecture material and notes, bibliography	20
Supplementary study in the library, online and in the field	-
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	20
Tutoring	2
Exams and tests	2
Other activities	0

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	Semiconductor physics. Spectral analysis of signals. Analysis of electronic circuits. Analysis and design of fundamental circuits with transistors. Time and frequency domain analysis of linear, time invariant systems.
4.2	Competence	Using personal computers and laboratory equipment (multimeters, oscilloscopes, etc), fundamental knowledge of computer aided design in electronics.

5. Requirements (where appropriate)

5.1	For the course	Amphitheatre, Cluj-Napoca
5.2	For the applications	Laboratory, Cluj-Napoca

6. Specific competences

Professional competences	Theoretical knowledge (what the student must know):	Electronics devices and circuits. Computer aided design. Circuit analysis and synthesis methods. Signals, circuits and systems.
	Acquired skills (what the student is able to do):	After attending the lectures the students should: - be familiar with the operation of the main integrated analog building blocks; - recognize the fundamental structures in complex analog circuitry; - know the performance indicators and parameters for each category of fundamental circuits; - create combinations of functional blocks in order to implement complex analog signal processing systems; - be capable of performance analysis on the designed; - be able to propose improvements based on the key performance indicators.
	Acquired abilities: (what type of equipment the student is able to handle)	After attending the lectures the students should be able to: - use analysis methods specific to each category of circuits; - use the simulator to verify tehoretical concepts; - save and anayze numerical data obtained through modelling and simulation; - determine the main circuit parameters from simulation data (gain, input/output resistance, bandwidth, slew-rate)
	In accordance with Grila1 and Grila2 RNCIS	C1. To use the fundamental elements regarding electronic devices, circuits, systems, instrumentation and technology C2. To apply basic methods for signal acquisition and processing C4. To design, implement and operate data, voice, video and multimedia services, based on the understanding and application of fundamental concepts from the field of communications and information transmission.
Cross competences (Grila1 and Grila2 RNCIS)		N.A.

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

7.1	General objectives	Development of competences in the area of advanced analog circuit analysis and design
7.2	Specific objectives	1. Ackquiring theoretical knowledge with emphasis on the internal structures and parameters of bipolar and CMOS operational amplifiers. 2. Developing skills in design and analysis of operational amplifiers based on a given set of functional specifications.

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	Integrated semiconductor devices. MOS and bipolar trasistors.	Presentation, heuristic conversation, exemplification, teaching exercise, interactive learning	Use of .ppt presentation, projector, blackboard
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. Applications (seminar)		Teaching methods	Notes
1	Current sources and sinks.	Presentation and problem solving, learning through cooperation, case studies and demonstrations	
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	Stability analysis of the opamps. Frequency compensation.		
8.3. Applications (lab)		Teaching methods	Notes
1	Transistors – biasing, characteristics, operating regions, setting the operating point.	Presentation and applications. Learning through exercise, trial and error, discovery on	Computer (specific software tools)
2	Design and analysis of electronic current sources.		
3	Current mirrors.		
4	Voltage and current references.		
5	Elementary voltage amplifier stages.		

6	Differential amplifiers.	industrial level simulators and CAD tools	
7	Miller compensated and folded cascode opamp architectures.		

Bibliography

1. D. Csipkes – Circuite Integrate Analogice. Circuite fundamentale – Casa Cartii de Stiinta, 2007;
2. L. Feştilă – Circuite integrate analogice 1 – Casa Cartii de Stiinta, 1997;
3. L. Feştilă – Circuite integrate analogice 2 – Casa Cartii de Stiinta, 1999;
4. P.E. Allen, D. Holberg – CMOS Analog Circuit Design, Second Edition, Oxford Press, 2002;
5. D. Csipkes, G. Csipkes – Fundamental Analog Circuits. Practical Simulation Exercises – UTPres, 2004;
6. D. Csipkes, G. Csipkes – Elemente constructive utilizate în proiectarea circuitelor analogice complexe – Casa Cartii de Stiinta, 2004;
7. L. Feştilă, D. Lupea – Circuite integrate analogice – Culegere de probleme, LITO UTCN, 1999;
8. L. Festila, D. Lupea – Teste de CIA – LITO UTCN 1998;
9. G. Csipkes, R. Groza – fascicole cu lucrari de laborator, uz intern, reactualizate anual.

On-line references

10. http://www.bel.utcluj.ro/ci/rom/cia1.html
11. D. Csipkes, Circuite integrate analogice – Seminar
12. G. Csipkes, R. Groza, Circuite integrate analogice – Laboratory
13. D. Csipkes, G. Csipkes, R. Groza – Grid Test

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

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. Evaluations

Activity type	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Curs		Problem solving		Written examination		80%
Aplicatii		Practical simulation exercises		Practical test		20%
10.4 Minimum standard of performance						
Evaluation 4,5 at exam , passed practical testing, final mark at least 5						

Date of filling in	Course responsible	Teachers in charge of applications
1.10.2018	Assist.Prof. Gabor Csipkes, PhD	Assist.Prof. Gabor Csipkes, PhD