SYLLABUS

Discipline name	Systems with Analog Integrated Circuits
Profile	Electronics and Telecommunications Engineering
Specialization	Telecommunications Technologies and Systems
Code	51323209
Course leader	Associate Professor Marius Neag, Ph.D – Marius.Neag@bel.utcluj.ro
Collaborators	Associate Professor Albert Fazakas, Ph.D – Albert.Fazakas@bel.utcluj.ro
Department	Bases of Electronics
Faculty	Electronics, Telecommunications and Information Technology

Sem.	Type of discipline	Course	Applications			Course	Applications			Ind. study	TOTAL	Credits	Form of assessment
		[hours/week]				[hours/sem.]							
			S	L	P		S	L	P				
5	**Engineering**	**2**	**-**	**2**	**-**	**28**	**-**	**28**	**-**	**64**	**124**	**5**	**Exam**

Acquired competences :

Acquired skills (what the student is able to do):

After completing the discipline, the students will be able to:
- Analyze the stability of closed-loop systems based on general-purpose operational amplifiers (OAs); design networks for frequency compensation;
- Analyze and design linear and nonlinear applications with OAs such as: amplifiers, filters, precision rectifiers, peak detectors, comparators;
- Estimate the effects of OA non-idealities and design circuits to minimize and/or compensate them;
- Analyze applications based on, and design circuits with, specialized integrated circuits such as: instrument amplifiers, analog multipliers, comparators and signal generators;
- Analyze and design circuits based on current-mode devices such as the Current-Feedback Operational Amplifier and the Current Conveyors;
- Analyze and design applications with integrated PLL circuits.

Acquired abilities: (what type of equipment/instruments/software the student is able to handle)

After completing the discipline, the students will be able to:
- Use the standard lab instrumentation (power supplies, oscilloscope, function generator, multimeter) for the experimental study of analog systems with OAs and specialized integrated circuits;
- Take accurate measurements, then process and analyze obtained data;
- Design and implement simple test-benches for the functional verification of analog systems and the measurement of their main parameters through SPICE-based simulations.

Prerequisites (if necessary)

Good understanding of the operation and parameters of main analog building blocks: amplifying stages with one- and two-transistors, the differential pair, current mirrors, voltage references;
Working knowledge about the internal structure of general purpose OAs.

A. Course/Lecture (course/lecture titles)	
1	Stability of closed-loop systems based on general-purpose OAs. Methods for internal and external frequency compensation of OAs.
2	Static and dynamic OA limitations; main parameters of OAs.
3	Effects of OA non-idealities in linear applications with OAs; methods for minimising and compensating for these effects
4	Precision and instrumentation amplifiers: features, parameters; classical implementation solutions in voltage-mode.
5	Current-mode instrumentation amplifiers: main principles and features of current-mode circuits; examples of current-mode implementation of instrumentation amplifiers; comparison with classical, voltage-mode, amplifiers.
6	Current-Mode active devices - the Current-Feedback Operational Amplifier and the Current Conveyors: operation; internal structure; modeling; parameters; main applications; comparison with traditional (voltage-mode) OA.
7	Noise in analog circuits: noise properties, modeling and analysis methods. OA noise and its effects on linear applications. Design of low-noise OAs and circuits.
8	Nonlinear circuits based on OAs: precision rectifiers; peak detectors; sample-and-hold amplifiers.
9	Integrated voltage comparators: internal structures; main parameters and limitations. Applications: summing and differential comparators; window comparators; Schmitt triggers.
10	Signal generators: main features and implementation techniques. OA-based generators: sine-wave;

	triangular & rectangular - wave; sawtooth wave generators. Integrated signal generators: principle of operation; examples.
11	Analog Multipliers - main features and implementation techniques: controlled MOS resistor; pwm; log/antilog; variable transconductance multipliers. Examples of and applications with integrated analog multipliers.
12	Integrated circuits specialised on complex analog functions: multiplier/dividers; timers, V-F and F-V converters.
13	PLL circuits – fundamentals: basic architecture and principle of operation; modeling and analysis; main parameters.
14	PLL circuits – implementation examples and applications.

B1. Applications – **Laboratory** (list of laboratories), **Seminar** (contents), **Project** (project contents)	
1	Stability analysis of OA-based feedback circuits.
2	Methods for internal and external frequency compensation of OAs.
3	OA parameters; effects of OA non-idealities on linear applications.
4	Methods for compensating for OA non-idealities.
5	Instrumentation Amplifiers operating in voltage-mode.
6	Instrumentation Amplifiers operating in current-mode.
7	Current-Feedback Operational Amplifiers and the Current Conveyors: parameters and applications.
8	Analysis and design of low-noise audio amplifiers.
9	Analysis of nonlinear circuits based on OAs.
10	Voltage comparators: OA-based and specialised ICs.
11	Signal generators.
12	Analog Multipliers.
13	Analog ICs with special functions.
14	Applications with PLL circuits.

C. Individual study (reference study contents, synthesis materials, projects, applications etc.)

14 sets of problems (course homework)
14 reference studies – such a study is required as preparation for each laboratory
14 reports, one following each laboratory

Individual study structure	Course study	Problem solving, laboratory, project	Applications preparation	Examination time	Additional reference study	Total no. of individual study hours
Hours	14	14	14	2	12	64

References (Textbooks, courses, laboratory manual, exercise book)

1. M. Neag, *Sisteme cu Circuite Integrate Analogice*, Mediamira, 2008
2. M. Neag, A. Fazakas, *Circuite Integrate Analogice*, Casa Cărții de Știință, 1999
3. P. R. Gray, R. G. Meyer, *Analysis and Design of Analog Integrated Circuits,* John Wiley and Sons, 2001
4. B. Razavi - *Design of CMOS Analog Integrated Circuits*, McGraw-Hill, 2001
5. Sergio Franco – Design with Operational Amplifiers and Analog Integrated Circuits, McGraw-Hill, 1998
6. K. Laker, W. Sansen – *Design of Analog Integrated Circuits and Systems*, McGraw-Hill, 1994

On – line references

1. M. Neag, Systems with Analog IC – course site: http://www.bel.utcluj.ro/ci/rom/cia2.html

Final evaluation	
Evaluation method	Written exam (E): problem solving (70%) and theoretical subjects (30%).
Mark components	Exam (E: 0…10 points); Laboratory (L: 0…10 points); Homework (H: 0…10 points);
Mark computation	M = 0.6E + 0.2L + 0.2H. Pass if: E≥4 and L≥4 and M≥4.5

Course leader,

Assoc. Prof. Marius NEAG, Ph.D.