COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_ ELE930**	**SEMESTER**	**9**
COURSE TITLE	DESIGN OF ANALOG MICROELECTRONIC CIRCUITS		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	
Seminars / Practice exercises	1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	4	5

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Specialised
PREREQUISITE COURSES:	No. Students are advised to have already attended the courses: Fundamental Electronics, Analog Electronics
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://www.ece.uop.gr/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning*

and Appendix B

- *Guidelines for writing Learning Outcomes*

The course expands and deepens the students' knowledge and capabilities in a wide range of analog circuits with emphasis on very large-scale integration (VLSI) on micro-nanoscale. The course's material aims to provide a deep knowledge on issues related to the physical – layout design of analog circuits VLSI, such as amplifiers, voltage and current sources, oscillators, power amplifiers, comparators and others. A presentation of the technique of good methods of physical design of semiconductor circuits, the avoidance of systematic construction errors and the treatment of endogenous construction problems is given. Students are taught about analog circuit design issues arising from the new trends in scaled-down integration from microscale to nanoscale. Special software for the design of integrated analog circuits is introduced.

Learning Outcomes

Upon successful completion of the course, student will be able to:

At the knowledge level:

- know of the basic steps of manufacturing integrated circuits.
- know the structure of the basic integrated elements.
- understand of analog integrated circuit design methods.
- Know about compensation for integration technology mismatches.
- be aware of ways of physically designing basic circuits, such as reference voltage generator and power sources.
- know ways of physically designing sensitive circuits, power amplifiers.
- identify problems by designing circuits on a nanoscale.

At the skill level:

- design reliable integrated analog circuits.
- design voltage reference generators and current sources.
- design sensitive circuits and operational amplifiers.
- use good layout techniques for designong in nanoscale level.

At the level of abilities:

- apply correct ways of analog circuits design depending on the circuit type.
- propose appropriate circuits for reference voltage generator and reference current generator.
- design integrated differential and operarational amplifiers.
- to solve problems designing circuits generated by the implementation technology limitations.
- develop different ways of physical design of a circuit.
- address the limitations of operating frequency with appropriate design techniques.
- evaluate the design problems at nanoscale level.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Adapting to new situations
- Working independently
- Team Work
- Working in an international environment
- Production of free, creative and inductive thinking
- Criticism and self-criticism
- Production of new research ideas

(3) SYLLABUS

Short Course Description

Study of analog circuits with emphasis on very large-scale integration (VLSI) on micro-nanoscale. Design of analog vlsi circuits, such as amplifiers, voltage and current sources, oscillators, operational amplifiers, comparators and others. Presentation of good methods of physical design of integrated

circuits, the avoidance of systematic mismatch errors and the solution of intrinsic design problems. Problems in layout of analog circuits at new downscaled nm integrated circuits. Software for the design of integrated analog circuits.

The course is developed in the following 13 lectures:

1. **Integration technologies**. Emphasis on CMOS technology. Basic steps of photolithography. Process of manufacturing integrated circuits.
2. **CMOS and BiCMOS**. Design techniques and the necessity for the coexistence of analog devices in very large-scale integration circuits (VLSI) together with digital devices.
3. **Structures of basic elements**. Basic electronics elements in integrated analog circuits: transistors, capacitors, resistors. Types and ways of designing the basic elements.
4. **Physical design rules**. Layout, design tolerances and mismatches, design margins.
5. **Scaling MOS transistors**. Reliability, limitations, interfaces. Methods of compensation for construction mismatches. Placements of dummy devices.
6. **Evaluation of MOS transistor**. Power consumption and operating speed. Large elements and circuits.
7. **Good practices on layout design**. Design of reliable analog integrated circuits with good design practices.
8. **Design of power sources**. Current mirrors and current sources. Design of reliable multiple-output current sources.
9. **Biasing circuit design**. Reference voltage generators and reference power sources. Their operation in relation to the technology tolerances.
10. **Physical design techniques in sensitive analog circuits**. Design of differential amplifiers, power amplifiers and transcondactance amplifiers.
11. **Operating frequency limitations**. The effect of integration technology parameters on operating speed. Design optimization for high frequencies.
12. **Modern trends in nanoelectronic technology**. Effects of the nanoscale on analog circuits.
13. **Computer aided design**. Design software. From the schematic to the final physical design.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face in-class lecturing</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Slides (ppt) of the presentation of the theoretical part of the course, which will be available from the beginning of semester through e-Class.
• Support of teaching procedure through the e-Class platform (notification of the teaching procedure, distribution of slides, supplementary material, announcements, relative links and literature, provision of test and the final examination).</td></tr>
<tr><td>TEACHING METHODS

The manner and methods of teaching are described in detail.

Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>39</td></tr><tr><td>Tutorials</td><td>13</td></tr><tr><td>Project</td><td>13</td></tr><tr><td>Study and analysis of bibliography</td><td>60</td></tr></table></td></tr>
</table>

workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*		
	Course Total	***125 hours (5 ECTS)***
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final written exam that includes: 1. Solving exercises 2. Comparative evaluation of theory elements	

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. B. Razavi. Design of analog CMOS integrated circuits, McGraw-Hill Education*, 2017.*
2. P.R. Gray, P.J. Hurst, S.H. Lewis και R.G. Meyer, Analysis and Design of Analog Integrated Circuits, 4th edition, John Wiley and Sons, 2001.
3. R. Jaeger, T. Blalock: Microelectronics, 5th edition, McGraw-Hill, 2010.
4. S. Sedra, K. C. Smith, Microelectronic Circuits, 7th edition, The Oxford Sereies in Electrical and Computer Enginnering, 2017.
5. J. Millman, A. Grabel, Microelectronics, McGraw-Hill College, 2014.

- *Related academic journals:*

1. IEEE Transactions on Circuits and Systems I
2. IEEE Transactions on Circuits and Systems II
3. IEEE Transactions on VLSI
4. IEEE Transactions on Industrial Electronics
5. IET Electronics Letters
6. IET Circuits, Devices & Systems
7. International Journal of Circuits Theory and Applications
8. Journal of Circuits Systems and Computers
9. Journal of Circuits Systems and Signal Processing
10. International Journal of Electronics
11. Microelectronics Journal