COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_K440**	**SEMESTER**	**4**
COURSE TITLE	ANALOG ELECTRONIC 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		
Laboratory	1	
Total	**4**	**5**
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).		

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Special background
PREREQUISITE COURSES:	No. It is suggested for the students to have adequate knowledge on electronic devices and electrical circuit analysis
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 main goal of the course is the thorough examination of the theory and the design of analog electronic circuits. In order to achieve that, the basic circuit theory is combined with fundamental electronic devices knowledge, as well as with devices modeling techniques. The coexistence of the afore-mentioned knowledge with practical exercises and examples intends to the familiarization of the students with analog electronic circuit applications, such as amplifiers of several types. The contents of the course have been selected, in order the acquired knowledge to become the background for the understanding, in a next phase, of the analog integrated circuits and systems design. The course is addressed to students with adequate knowledge on electronic devices and electrical circuit analysis.

The most common processing of analog signals is their amplification, which is achieved by using two-

port circuits that are referred as amplifiers. An amplifier uses the power from a power supply to increase the amplitude of a signal (that is generated from a voltage or current source) applied to its input terminals, producing a proportionally greater amplitude signal at its output. The amount of amplification provided by an amplifier is measured by its gain (or amplification): the ratio of output voltage or current to the input voltage or current.

An amplifier receives input from a signal source and drives a load, i.e. it operates as a matching circuit between signal source and load. The proportion that holds between the output and the input signal of amplifiers is the reason that such circuits are referred as analog circuits. The basic subject of the course is the design and the analysis of several amplifier types, and within the context of the course we explore issues, such as: single stage amplifiers, transistors' operation in high frequencies, frequency response of amplifiers, multiple stage amplifiers, feedback amplifiers, operational amplifier, power amplifiers, filter and basic vibrator circuits.

Keywords: Analog electronic circuits, electronic devices, amplifiers, analog filters.

Learning Outcomes

After the successful completion of the course, the students will be able to:

1. understand the design and the operation of single stage amplifiers,
2. analyze single stage amplifiers in DC and AC and to compute their basic parameters,
3. understand the operation of bipolar and MOSFET transistors in the range of high frequencies and to determine the frequency response of single-stage amplifiers,
4. perceive and design several types of multiple stage amplifiers and to understand their characteristics and the applications that each of them can be used,
5. know the influence of negative feedback to the amplifiers' characteristics and the existing topologies of negative feedback in amplifier circuits,
6. understand the operation and the structure of the operational amplifier, and to perceive and design several analog signal processing circuits that are based on the operational amplifier,
7. perceive, analyze and design several types of power amplifiers and to compute their basic parameters,
8. design and analyze analog frequency filters,
9. understand the operation of basic vibrator circuits.

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
- Decision-making
- Working independently
- Team Work
- Production of free, creative and inductive thinking

(3) SYLLABUS

The course lectures cover the following thematic areas:

1. Review of basic electrical circuit theory, and fundamental electronic devices (diodes, bipolar transistor and MOSFET) operation.

2. Single stage amplifiers: DC analysis, biasing schemes of BJT amplifiers, DC load line, AC analysis (small signal operation), small signal models and equivalent circuits, input and output impedances, midband gain (amplification) computation, common-emitter single stage amplifier, characteristics.

3. Common-base and common-collector single stage amplifiers and their characteristics, AC load line, introduction to amplifier frequency response, single stage MOSFET amplifiers DC and AC analysis, common-source single stage MOSFET amplifier.

4. Transistor operation in high frequencies: BJT transistor's internal capacitances, high frequency small-signal π-model, modified high frequency model (Miller theorem), analysis of the BJT transistor operation in high frequencies, current amplification in high frequencies, cutoff frequency, MOSFET's internal capacitances, MOSFET high frequency small-signal π model.

5. Frequency response of single stage amplifiers: frequency response of low-pass and high-pass RC circuits, amplifiers low-frequency response, amplifiers high-frequency response, frequency response of common-emitter and common-base amplifiers, cutoff frequencies computation, amplifiers timing response.

6. Multiple-stage amplifiers: successive amplifier stages, coupling techniques (capacitive coupling, direct coupling, transformer coupling), Darlington pair, common-collector - common-emitter amplifier, cascade amplifier, differential amplifier with bipolar transistors and MOSFETs.

7. Feedback in amplifiers: feedback general structure, properties of negative feedback in amplifiers (gain desensitivity, bandwidth extension, noise and distortion reduction), voltage, current, transconductance and transresistance amplifiers, amplifier feedback topologies (voltage-mixing voltage-sampling, current-mixing current-sampling, voltage-mixing current-sampling and current-mixing voltage-sampling), frequency response of amplifiers with negative feedback..

8. Operational amplifier, part I: structure, operation and applications of the operational amplifier, ideal operational amplifier, voltage follower, inverting and non-inverting operational amplifier configurations, analysis methods for operational amplifier circuits, difference amplifiers, inverting and non-inverting adder circuits.

9. Operational amplifier, part II: integrator and differentiator circuits, amplifier with differential input and output, instrumental amplifier, current to voltage and voltage to current converters, rectifiers, voltage comparators, voltage-level detectors, operational amplifier frequency response.

10. Power amplifiers: classes of amplifier stages (output stages), class A, class B, class AB and class C amplifiers, class A common emitter power amplifier with direct load coupling, class A common collector power amplifier with capacitive load coupling.

11. Class A common emitter power amplifier with transformer load coupling, push-pull amplifier with transformer, push-pull amplifier with complementary transistors.

12. Analog filters and vibrators: basic filter theory, frequency response characteristics (low pass, high pass, band-pass, band-reject), methods for filter response estimation, active filters.

13. Passive LC filters, LC vibrators, vibrators analysis techniques, Wien-bridge vibrator.

The practical part of the course includes:

Measurements and practical study of Ge and Si pn-junctions and Zener diode, practical study of half-wave and full-wave rectifiers, measurements and practical study of BJT transistors, practical study of

two-stage BJT amplifier (capacitive and direct coupling), practical study of differential amplifier and operational amplifier.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face in-class lecturing
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Slides (ppt) of the presentation of the theoretical part of the course, which will be available from the beginning of semester through e-Class. • Combined use of projector (for slides) as well as of whiteboard. • Guidelines for the practical exercises (one for each exercise), which will be available from the beginning of the semester through e-Class. • Homework assignments after the completion of each exercise. • 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) • Specialized software and hardware relevant to the course.
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 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.*	
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.*	Evaluation of theoretical part through final written exam that includes solving exercises, multiple choice questions, comparative evaluation of theory elements. Evaluation of the practical part through the homework assignments, a semester mid-time short written exam that includes solving exercises and multiple choice questions and a final exam that includes a written exam (solving exercises and multiple choice questions) as well as a short practical part. The final grade is the weighted result of the grades of the theoretical part and the practical part of the course. The weights are defined and the beginning of each semester and they will be announced via e-Class. The final exams are in Greek language. The examination process and the evaluation criteria are publicly available to the students through e-Class.

Activity	***Semester workload***
Lectures	39
Laboratory	13
Practical exercises preparation and homework assignment	24
Study of lectures and bibliography	49
Course total	**125 hours (5 ECTS)**

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. J. Haritantis, Electronics II: Analog electronics, Arakynthos University Editions, 2007.
2. R. L. Boylestad, L. Nashelsky, Electronic devices and circuit theory, Pearson, 2008.
3. Malvino, D. J. Bates, Electronic principles, McGraw-Hill, 2015.
4. A. S. Sedra, K. C. Smith, Microelectronic circuits, Oxford University Press, 2017.
5. A. R. Hambley, Electronics, Pearson, 2000.
6. K. C. Smith, Laboratory explorations for microelectronic circuits, Oxford University Press, 1998.

- *Related academic journals:*

1. IEEE Transactions on Circuits and Systems I & II
2. IEEE Open Journal of Circuits and Systems
3. IEEE Circuits and Devices Magazine
4. IEEE Circuits and Systems Magazine
5. IEEE Transactions on Electron Devices
6. IEEE Electron Device Letters
7. IET Eletronics
8. IET Electronics Letters
9. IET Circuits, Devices & Systems
10. International Journal of Electronics, Taylor & Francis
11. International Journal on Circuit Theory and Applications, Wiley