INSTITUTION	NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS					
SCHOOL	SCHOOL OF SCIENCE					
DEPARTMENT	INFORMATICS AND TELECOMMUNICATIONS					
COURSE LEVEL	UNDERGRADUATE					
COURSE TITLE	**Circuits and Systems Laboratory**					
COURSE CODE	**K11ε**		**Semester**	**3**	**ECTS**	**2**
TEACHING HOURS per week	**THEORY**		**SEMINAR.**		**LABORATORY**	**2**
COURSE TYPE	Optional Lab (EP) **K** | **E1** | **E2** | **E3** | **E4** | **E5** | **E6** *Fill the table as in the curriculum: Track (A-Computer Science, B- Computer Engineering) / Specialization Compulsory (Y) / Core Specialization (B)/ Elective Specialization (E)*					
URL	https://eclass.uoa.gr/courses/DI320/					
EXPECTED PRIOR KNOWLEDGE/ PREREQUISITES AND PREPARATION:	Recommended K12					
TEACHING AND EXAMINATIONS LANGUAGE:	GREEK					
THE COURSE IS OFFERED TO ERASMUS STUDENTS	NO					

COURSE CONTENT
Circuit theory is covered with an emphasis on the analysis and the solving of exercises for both DC and AC for their permanent and transient states. The Circuit and Systems Laboratory is also presented, as well as its instruments, equipment and measurement methodology. Emphasis is given to the practical training in the construction and analysis of actual circuits and to obtaining correct measurements of electrical quantities. In particular, the following topics are included: 1. Basic circuits elements: active and passive elements (resistance, capacitor, inductor, operational amplifier, polarity conventions, earthing), current-voltage plots (Ohm's law), signals (DC, AC, power, rms values analog, digital). 2. Linear Networks: basic laws and rules for circuit analysis (nodes, branches, loops, elements connected in series and parallel, Kirchhoff rules, voltage and current dividers, superposition principle, Thevenin and Norton theorems, duality, real voltage and current sources. maximum power transfer).

3. Circuits with energy storage elements: RC-RL (transient response, frequency response, impedance, low or high frequency pass filters, resonant circuits).
4. Operational Amplifiers (OpAmp): internal circuits and applications of OpAmps, ideal and real OpAmps (Texas Instruments LM741), basic OpAmp circuits (inverted amplifier, non-inverted amplifier, voltage follower, adder, differential amplifier, integrator, differentiator).
5. Methodology for selecting electrical elements and circuit connections: real passive and active elements, signal generators, breadboards, wiring, earthing.
6. Measurement methodology: laboratory instruments and principles of operation (multimeters, oscilloscopes), voltage, current, resistance, phase difference measurements, display of time-varying signals, graphs of measured quantities, calibration.

STUDENT LEARNING OBJECTIVES

Teaching and Learning Objectives

The objective of the course is to familiarize students with the Circuits and Systems Laboratory and especially its scientific instruments and basic circuit components: passive circuit components (resistors, inductors, capacitors), active components (OpAmps), breadboards, cables, earthing, multimeters, oscilloscopes, sources. Understanding the behavior of these basic electronic components leads to the prototyping, analysis, understanding and maintenance of electronic systems.

Expected Learning Outcomes

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

- Define electrical current, current density, voltage and basic SI units.
- Identify the basic circuit components (conductor, resistor, capacitor, inductor, OpAmp, source, variable resistor), detect their electrical quantities, construct their i-v plots, identify their physical shapes and their physical limits.
- Locate the basic elements of linear circuits (node, branch, loop, short circuit, open circuit).
- Redesign resistor networks to facilitate the calculation of equivalent resistance between two nodes and apply Ohm's law, voltage and current divider rules, sign and Kirchhoff rules, to simple electrical circuits for their analysis.
- Apply the superposition principle, the Thevenin and Norton equivalents, and the maximum power transfer theorem for calculating the electrical quantities of each circuit component (load, current, voltage, magnetic flux, power, stored energy) for DC circuits.
- Construct differential equations for circuits comprising inductors and capacitors.
- Calculate the instantaneous, mean and rms values of any periodic waveform and explain the physical significance of these values for power.
- Convert sinusoidal voltages and currents to phasors and vice versa, and design equivalent AC circuit representations and apply DC circuit analysis methods to AC circuits using phasors.
- Explain the fundamental properties of transient responses, and determine the DC steady state and the complete solution of first order circuits containing inductors and capacitors.
- Explain the physical importance of the analysis in the frequency domain and calculate the frequency and phase response for periodic signals,
- Recognize and assemble simple first-order passive electrical filters and explain their responses and properties.
- Explain the properties of OpAmps and the concepts of gain and input and output impedance, and detect the differences between open loop and closed loop circuits.
- Recognize the circuit diagram and calculate the gain of the simple inverting and non-inverting amplifier, adder and differential amplifier.

- Design circuits on paper, construct the corresponding actual circuits in the laboratory, test them and convert them in both forms (diagram and real circuit).
- Explain the effect of internal resistance on real voltage and current sources and on voltage and current measuring devices.
- Handle and adjust the Circuits and Systems Laboratory equipment and instruments and their external connections (cables, educational boards, breadboards, multimeters, oscilloscopes, signal generators).
- Correctly measure actual circuits' electrical quantities with the actual measuring instruments of the laboratory.
- Record, plot and compare measurement results, and calibrate plots of measurements in linear and semi-logarithmic axes.

TEACHING AND LEARNING METHODS - ASSESSMENT	
TEACHING METHOD	In Class and in Laboratory (Face to Face)
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES	Support for the learning process through the eClass platform and in particular the modules: course description, distribution of educational material, announcements, messages, lecture and lab calendar, evaluation feedback, comments, user groups. E-mail communication. Circuit and System Laboratory is equipped with wiring harnesses, circuit boards, breadboards, complete collections of passive elements of various sizes and types (resistors, capacitors, coils), active element collections (OpAmps), DC and AC generators, digital multimeters, oscilloscopes.
TEACHING ORGANIZATION *Describe in detail the way and methods of teaching:* *Enhanced Lectures,* *Online Lectures,* *Seminars,* *Tutorial,* *Laboratory,* *Laboratory Exercise,* *Study & analysis of literature,* *Practice (Positioning),* *Interactive teaching,* *Developing a project,* *Individual / group work* *Telework (reference to tools) etc.* *Details of the student's study hours for each learning activity and hours of non-guided study are shown to ensure that the total workload at the semester corresponds to the ECTS*	Class lectures take place in a classroom using slides and videos, and teaching techniques for activating students and highlighting their experiences such as questions / responses and discussion. Slides and more comprehensive lecture notes are distributed to students in electronic format (the notes booklet is also available to all and in printed form). Laboratory activities take place at the Circuits and Systems Laboratory, where students practice through exercises, in order to familiarize with the equipment, regulate it, complete circuits using circuit boards, create new circuits in breadboards, test their connections and take measurements through the measuring instruments. For each laboratory exercise they are given special forms, which include the statements of their exercises, while on the same forms they complete their measurements, answer questions, perform calculations, draw the graphs of their measurements, record their calculations, and deliver them to the instructor, each time before leaving the lab room. Students in the laboratory are divided into groups of three, and cooperation between the members of each group is allowed. The lab has multiple workstations (10), whereupon 30 students are trained under the close supervision of the teachers and with the help of laboratory assistants. At each lab day, information on safety, handling

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and wiring rules are first given orally, in order to avoid damage to laboratory equipment (the electrical features of the equipment and the electrical installation prevent personal injury from electric shock). During the laboratory exercises the progress and correctness of the wiring is continuously monitored and the voltage / current sources are activated, each time, only after thorough control of each circuit by the laboratory staff. When necessary, corrections and changes of connections are made on the spot and are explained to the student (s).
Finally, students are asked to study the corresponding slides, notes, laboratory exercise forms, and laboratory equipment manuals before each laboratory exercise.
<table>
<tr><th>Activity</th><th>Student Workload (hours)</th></tr>
<tr><td>Lectures</td><td>10</td></tr>
<tr><td>Laboratory (briefing, practice, exercise completion, form submission)</td><td>10</td></tr>
<tr><td>Study of relevant literature prior to each laboratory</td><td>10</td></tr>
<tr><td>Preparation for the exams</td><td>20</td></tr>
<tr><td>Total Course</td><td>50</td></tr>
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ASSESSMENT OF STUDENTS
Description of the assessment process

Assessment Methods, Formative or Concluding, Multiple Choice Test, Quick Response Questions, Test Development Questions, Problem Solving, Written Work, Report / Report, Oral Examination, Public Presentation, Laboratory Work, Other / Other

Fully defined evaluation criteria are mentioned and if and where they are accessible to students.
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The course involves a formative assessment of the lab's activities combined with final written examinations.
During laboratory activities, open notes are allowed. Laboratory activities forms (separate for a total of 5 exercises) are submitted by the student (s) at the end of each exercise. These lab forms, supplemented by measurements, calculations, answers to short answer questions, and student graphs are individual and are rated as technical reports of laboratory exercises. This score is being fed back to the students through eClass during the semester. The average grade of the worksheets, on a scale of integers with a maximum of 10, contributes 50% to the final grade.
In addition, the course includes final written examinations with closed notes. Students are required to solve circuit analysis exercises (on paper, outside the lab) and are rated for problem solving (problem analysis, solution justification, presentation and result). The total grade of final written examinations, on a scale of integers with a maximum of 10, contributes 50% to the final grade.
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<tr><th>Assessment methods</th><th>Number</th><th>Percentage</th></tr>
<tr><td>Written examination</td><td>1</td><td>50%</td></tr>
<tr><td>Laboratory activities (lab forms)</td><td>5</td><td>50%</td></tr>
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LITERATURE AND STUDY MATERIALS / READING LIST
Suggested textbooks:

1. Rizzoni, G., Kearns, J., and Christides, C. V. (2018). Circuit Theory and Basic Electronics (in Greek). Papazisis Publications, ISBN 9789600234053.
2. Loutrides, S. (2018). Electric Circuits – Analysis Applications with MATLAB and SPICE (in Greek). Tziola Publications, ISBN 9789604185856.
3. Tsivides, G. (2018). Introductory Laboratory of Circuits and Electronics (in Greek). Papasotiriou Publications, ISBN 9789604911219.

Additional bibliography

1. Arapogianni, A. (2014). Circuits and Systems Laboratory. NKUA, Department of Informatics and Telecommunications..