COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	2601003	**SEMESTER**	1
COURSE TITLE	Electronic Physics & Optoelectronics		

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 (ECTS)**
Lectures	4	7
Laboratory	4	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General Background Course
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (in English)
COURSE WEBSITE (URL)	http://www.electronics.teipir.gr/menu_el/personalpages/papageorgas/download/Electronics/ http://www.electronics.teipir.gr/menu_el/spoudes/proptyxiaka/Ergastiria/Hlektroniki_fysiki_&_Optikohlektronikh/index.htm

(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*
In the Electronic Physics & Optoelectronics course, the student acquires fundamental knowledge on electronic devices, on the physics of semiconductors and on basic optoelectronics. The student will be able to understand and to use the concepts of modeling, to understand the behavior of electronic components and perform analysis and design of bias circuits (DC analysis) for diodes and transistors. More specifically, upon the students possess advanced knowledge, skills and competences

in the subject of Electronic Physics and Optoelectronics that enable them to:

- Know, understand and be able to state the basic concepts of semiconductor devices;
- Describe the operation of a p-n junction;
- Draw diagrams and explain the operation of a diode and a LED;
- Know, identify and classify Bipolar Junction Transistors and Field Effect Transistors;
- Analyze and design simple bias circuits for the above type of active components;
- Know and be able to explain by drawing voltage-current diagrams the operation of Zener diodes; discuss their relative merits in comparison to simple diodes; analyze and design circuits that contain Zener diodes;
- Analyze and design bias circuits for BJTs;
- Analyze and design bias circuits for FETs;
- Know, understand and be able to use small signal model in place of active components; differentiate among various types of components and select the appropriate model for use.

The Laboratory Experiments have been designed to initiate first year Electronics Engineers to the principles of experimentation in the laboratory, to give them basic measurement and use of instrumentation skills and teach them in practice the fundamentals of semiconductors through appropriately designed experiments.

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
- Working independently
- Team work

(3) COURSE CONTENT

Lectures

Lectures are given twice a week, for 13 weeks. Each lecture has a duration The material presented is divided in five (5) units:

Unit 1 Introduction, the meaning of modeling in science (4h)

Lecture 1: Introduction to the course objectives, structure and organization, requirements and obligations of students. Presentation of passive and active elements in electronics, methodology of describing active elements using the equivalent model concept.

Lecture 1b: Examples of equivalent models in science generally and especially in electronics. How do we pass from the physical functions and features of an electronic component to the model that describes its functionality. Use of simulation programs for electronic circuit design. Examples using the MULTISIM program (educational edition)

Unit 2 Semiconductor Physics (12h)

Lecture 2: Conductors, semiconductors, insulators and conductivity. Atomic structure of elements, the valence layer.
Lecture 2b: Energy levels for various elements. Emission - absorption of photons in the electromagnetic spectrum. Synoptic presentation of the emission spectrum of various sources.
Lecture 3: The semiconductor crystal. Transformation of the energy levels to the energy bands. Explanation of conductivity through energy zones.
Lecture 3b: Intrinsic Semiconductor, the electron - hole pair concept. Extrinsic semiconductor, the concept of doping. Calculations of density for electron - holes.
Lecture 4: Conductivity of conductors and semiconductors. The concept of mobility of the electrons - holes. Conductivity calculation.
Lecture 4b: Recapitulation of the concepts presented in the second section. Exercises on conductivity calculation and semiconductor resistance.

Unit 3 The junction Diode (12h)

Lecture 5: The p-n junction, diffusion currents, creation of the depletion region.
Lecture 5b: The p-n barrier potential, forward and reverse biased diodes.
Lecture 6a: Detailed description of the p-n junction diode. Calculation of the potential barrier, diode currents in correct and reverse polarity.
Lecture 6b: Operation of the diode in the Breakdown region- the zener diode. The p-n junction capacitance, the varactor diode. Operation principles for diodes, LEDs, photodiodes. Photovoltaic modules.
Lecture 7: The diode in a circuit. Calculation of the operating point using the graphical method. Diode Equivalent models for operation DC. Circuit examples.
Lecture 7b: Recapitulation of the concepts presented in the third section. Exercises with diode circuits.

Unit 4 The Bipolar Junction Transistor (12h)

Lecture 8a: Structure and symbols for BJTs, physical operation.
Lecture 8b: Currents flowing through the bipolar transistor, the meanings of the parameters α& β, Ebers-Moll model for large currents.
Lecture 9: Approximate operation of the bipolar transistor, examples of BJT circuits.
Lecture 9b: The common emitter characteristics for input – output, circuit examples.
Lecture 10a: The biasing of the bipolar transistor. Analysis of bias circuits in common emitter topology (DC analysis).
Lecture 10b: Repeat the concepts developed in the fourth section. Exercises on transistor biasing circuits.

Unit 5 The Field Effect Transistor (12h)

Lecture 11a: Physical operation MOSFET, the threshold voltage. Important design characteristics of a MOS-FET
Lecture 11b: Symbols for enhancement MOS-FETs, input-output characteristics, comparison with

the bipolar transistor.
Lecture 12a: Symbols for depletion MOS-FETs, input-output characteristics, comparison with the bipolar transistor. Symbols for JFETs, input-output characteristics, comparison with the bipolar transistor.
Lecture 12b: The current of a MOS-FET operating in the saturation area, analysis of bias circuits and calculation of the operating point (DC)

Recapitulation (4h)
Recapitulation of the theoretical material, solving examination exercises of past years.

Laboratory Experiments
GROUP A: Introductory experiments
1. Recognition of the gauges and general measurements
2. The OHM's Law
3. Principles of connecting resistors in series
4. Principles of connecting resistors in parallel
5. The 1st Kirchoff law
6. The 2nd Kirchoff law
7. Potentiometers and resistors
8. Electric power and energy
9. Studying Wire lamps
10. Studying VDRs
11. Studying Thermistors

GROUP B: Experiments with the oscilloscope and diodes
1. Oscilloscope I
2. Oscilloscope II
3. Oscilloscope III
4. P-N Diodes
5. Zener Diodes
6. The LED Diode
7. Photodiodes

GROUP C: Experiments on Transistors
1. Transistors (In General)
2. Transistors in CE topology
3. Transistors in CB topology
4. FET
5. MOSFET
6. TRIAC
7. DIAC
8. Phototransistor

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of electronic presentation with multimedia content in class, • Student support through the course webpage and the departmental e-learning platform,

	• Electronic communication of instructors and students, through the course webpage and by e-mail. • Use of specialized circuit simulation software.
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*	Lectures, laboratory experiments, assignments, study.

Activity	***Semester workload (hours)***
Lectures	52
Study for lectures - assignments	52
Laboratory experiments	52
Report on lab experiments	26
Study and preparation for exams	28
Course Total	**210**

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 course grade = Lectures part grade x 60% + Laboratory part grade x 40%. *Lectures part grade results from:* Final exam (80%) and Homework (20%) *Laboratory part grade results from:* • The students attending the lab, must be familiar with the theory of the specific exercise. During the lab experiment they implement the specific circuits, they complete their measurements and try to get answers for their questions. The next time they visit the lab they must deliver a report for the particular experiment. Their presence at the lab is obligatory. • Each exercise is evaluated with a grade that results from the evaluation of the report and his oral presence. The oral results are announced during the exercise duration. • The final examination includes oral and practical exams. The final Laboratory grade is calculated by a formula announced to the students at the start of each semester. Normally the final examination has a weighting factor of 0.7 and the oral examination with the homework has a weighting factor of 0.3.

(5) ATTACHED BIBLIOGRAPHY

Essential reading

1. J. Haritantis, Electronics I- Introduction to Electronics, Arakynthos Editions ISBN: 978-960-91034-6-6 (In Greek)

2. John Kostis, Laboratory manual (In Greek)

Recommended Books

1. Albert Malvino, Electronic Principles, McGraw-Hill, (in Greek), Tziolas Editions, Thessaloniki, Greece
2. Albert Malvino, Basic Electronics-Introduction to transistors and Integrated circuits, Tziolas Editions (In Greek)
3. Richard C. Jaeger, Microelectronics A, Tziolas Editions, (In Greek)
4. Jacob Millman & Arvin Grabel, Microelectronics Vol. A, Tziolas Editions (In Greek)
5. Millman J. and C. Halkias, Electronic Devices and Circuits, Papasotiriou Editions, (In Greek)
6. Sedra, A.S. and K. C. Smith, Microelectronic Circuits, Vol. A, Papasotiriou Editions, (translated into Greek).