Course Title	Electrical and Electronic Materials and Devices				
Course Code	AEEE138				
Course Type	Compulsory				
Level	BSc (Level 1)				
Year / Semester	2nd / 1st				
Teacher's Name	Prof Christos Themistos/ Dr Photos Vryonides				
ECTS	6	Lectures / week	3	Laboratories / week	
Course Purpose and Objectives	This course aims to provide an understanding about basic materials science and device engineering concepts required in electrical engineering, semiconductor operation and semiconductor devices. Basic concepts such as crystal structures, basic quantum mechanics for electrons in solids, bandgap and semiconductors, metals, dielectrics, and magnetic materials will be covered. Basic operation of PN junctions, transistors, dielectric devices, and other electronic devices is explained and related to material properties.				
Learning Outcomes	By the end of the course, students must be able to: 1. Define the electrical properties and characteristics of semiconductor materials and devices. Identify the electrical properties of. Determine the electrical properties of a single-crystal material by the arrangement of atoms in the solid. Appraise several growth techniques. 2. Classify the operation and characteristics of semiconductor devices. Understand the current– voltage characteristics of electron behavior in a semiconductor when the electron is subjected to various potential functions. 3. Describe the characteristics of electrons in a semiconductor by the formulation of quantum mechanics. Use Schrodinger's wave equation and become comfortable with the analysis techniques. 4. Determine a few of the characteristics of electrons in a single-crystal lattice. Apply these concepts specifically to a semiconductor material. In Estimate the density of quantum states in the conduction band and the density of quantum states in the valence band along with the Fermi–Dirac probability function to determine the concentration of electrons and holes in the conduction and valence bands, respectively. 5. Describe the two basic transport mechanisms in a semiconductor crystal: drift— the movement of charge due to electric fields, and diffusion—the flow of charge due to density gradients. 6. Describe the situation in which a p-type and an n-type semiconductor are brought into contact with one another to form a pn junction. Develop the current–voltage characteristics of the pn junction. 7. Use the bipolar transistor in analog electronic circuits and explain				

	its high current gain. Identify two complementary configurations of BJTs, the npn and pnp devices. 8. Define the Metal–Oxide–Semiconductor Field-Effect Transistor (MOSFET). Explain the fundamental physics of the MOSFET. Use the MOSFET in digital circuit applications. 9. Classify optical devices and discuss. the basic principles of solar cells, several photodetectors, light emitting diodes, and laser diodes.		
Prerequisites	AEEE170	Required	
Course Content	**The crystal structure of solids:** Overview of semiconductor materials and their use. Space Lattices. The diamond structure. Atomic bonding. Imperfections and impurities in solids. Growth of semiconductor materials **Quantum mechanics:** Principles of quantum mechanics. Schrodinger's wave equation. Application of Schrodinger's wave equation. Extensions of the wave theory to atoms. **The semiconductor in equilibrium:** Charge carriers in semiconductors. Dopant atoms and energy levels. The extrinsic semiconductor. Statistics of donors and acceptors. Fermi energy level. **Carrier Transport Phenomena:** Carrier drift. Carrier diffusion. Graded impurity distribution. The hall effect. **The PN Junction:** Basic structure of the PN junction. Zero applied bias. Reverse applied bias. Junction breakdown. Nonuniformly doped junctions. Small signal model of the PN junction. The tunnel diode. **The Bipolar Transistor:** The bipolar transistor action. Minority carrier distribution. Transistor currents and low-frequency common-base current gain. Equivalent circuit models. Frequency limitations. **Metal-Oxide Semiconductor Field Effect Transistor:** The two terminal MOS structure. Capacitance voltage characteristics. Basic MOSFET operation. The CMOS technology. **Optical devices:** Optical absorption. Solar cells. Photodetectors. Photoluminescence and electroluminescence. Light emitting diodes. Laser diodes.		
Teaching Methodology	Students are taught the course through lectures (3 hours per week) in classrooms or lectures theatres, by means of traditional tools or using computer demonstration. Auditory exercises, where examples regarding matter represented at the lectures, are solved and further, questions related to particular open-ended topic issues are compiled by the students and answered, during the lecture or assigned as homework. Topic notes are compiled by students, during the lecture which serve to cover the main issues under consideration and can also be downloaded from the e-learning platform or the lecturer's webpage. Students are also advised to use the subject's textbook or reference books for further reading and practice in solving related exercises. Tutorial problems are also submitted as homework and these are solved during lectures or privately		

	during lecturer's office hours. Furthermore, design projects may be assigned to the students, where literature search is encouraged to identify a specific problem related to some issue, gather relevant scientific information about how others have addressed the problem, implement to implement the design and report the results in written or orally.
Bibliography	**Textbooks:** • Donald A. Neamen "Semiconductor Physics and Devices Basic Principles" McGraw Hill, 2012. **References** • B. Streetman, S.K. Banerjee, Solid State Electronic Devices, 7th Ed., Pearson, 2016
Assessment	The Students are assessed via continuous assessment throughout the duration of the Semester, which forms the Coursework grade and the final written exam. The coursework and the final exam grades are weighted 40% and 60%, respectively, and compose the final grade of the course. Various approaches are used for the continuous assessment of the students, such as mid-term written exam, oral exam, quizzes AND design assignments.The assessment weight, date and time of each type of continuous assessment is being set at the beginning of the semester via the course outline. An indicative weighted continuous assessment of the course is shown below: • Assignments 10% • Homework 10% • Mid-Term written exams 50% • Design Project 20% • Quizzes 10% Students are prepared for final exam, by revision on the matter taught, problem solving and concept testing and are also trained to be able to deal with time constrains and revision timetable. The criteria considered for the assessment of each type of the continuous assessment and the final exam of the course are: (i) the comprehension of the fundamental concepts and theory of each topic, (ii) the application of the theory in solving related problems and (iii) the ability to apply the above knowledge in more complex design problems. The above cretiria are weighted 30%, 40% and 30%, respectively. The final assessment of the students is formative and summative and is assured to comply with the subject's expected learning outcomes and the quality of the course.
Language	English