AEEE456 - Power Electronics

Course Title	Power Electronics				
Course Code	AEEE456				
Course Type	Compulsory				
Level	BSc (Level 4)				
Year / Semester	4th (Spring)				
Teacher's Name	Assoc. Prof. Antonis Papadakis				
ECTS	6	Lectures / week	3	Laboratories/week	0
Course Purpose	The aim of the course is to familiarize the students with the concepts and the principles of power electronics. Specifically, we discuss the most popular and widely used power electronic devices such as diodes, transistors and thyristors, as well as their application in circuits.				
Learning Outcomes	By the end of the course, students must be able to: 1. Describe a brief history of the development of power electronic devices. 2. Describe the different applications of power electronics. 3. Explain the fundamental operation of power electronic devices. 4. Describe the different power electronic devices' range of operation. 5. Clarify the ideal characteristics of power electronic devices and limitations. 6. Analyze basic power electronic circuits that include power diodes, thyristors and transistors. 7. Explain the ideal characteristics of a switch. 8. Define the characteristics of practical devices. 9. Describe the most important switch specifications provided by manufacturers. 10. Define the different types of power electronic circuits. 11. Understand the power diode characteristics and its models. 12. Comprehend the series and parallel operation of diodes. 13. Explain the power diode characteristics. 14. Apply the Shockley diode equation. 15. Plot the current-voltage curve of pn diodes in the practical and ideal cases. 16. Explain the physics involved in the forward biased, reversed biased and breakdown regions of the pn junction. 17. Calculate the saturation current of a pn power diode. 18. Calculate reverse recovery characteristics such as peak reverse current, reverse recovery time, reverse recovery charge, softness factor, 19. Distinguish between the three different types of diodes such as the standard or general purpose, fats recovery and Schottky diodes. 20. Explain the different characteristics of silicon carbide diodes.				

	21. Analyze circuits with diodes at RC, RL, LC and RLC loads. 22. Comprehend the concept of freewheeling diode and be able to calculate the stored energy in a freewheeling diode. 23. Explain Bipolar Junction Transistors basic structure and their operation. 24. Analyze the static characteristics of bipolar junction transistors. 25. Analyze the dynamic characteristics of bipolar junction transistors. 26. Solve problems involving power electronic circuits such as dc choppers, dc step down converters, dc step up converters. 27. Describe the characteristics of an ideal power rectifier. 28. Distinguish between ideal and actual characteristics of a power rectifier.		
Prerequisites	AEEE239	Corequisites	None
Course Content	• Introduction to Power Electronics: Applications of Power Electronics, History of Power Electronics, Power Semiconductor Devices- Power Diodes, Thyristors, Power Transistors. • Control Characteristics of Power Devices: Characteristics and Specifications of Switches- Ideal Characteristics, Characteristics of Practical Devices, Switch Specifications, Types of Power Electronic Circuits. • Design of Power Electronics Equipment: Square Values of Waveforms, Peripheral Effects, Power Modules, Intelligent Modules. • Power Diodes: Diode characteristics and its models, Types of diodes, Series and parallel operation of diodes, Unidirectional device like a diode on RLC circuits, Freewheeling and stored-energy recovery. • Power Thyristors: Introduction, Basic Structure and Operation, Static Characteristics, Switching Characteristics, Thyristor Parameters, Types of Thyristors, Gate Drive Requirements, Applications. • Power Transistors: Introduction, Basic Structure and Operation, Static Characteristics, Dynamic Switching Characteristics, Transistor Base Drive Applications, BJT Applications. • Applications and Problems: Chopper Circuits, Step Down Converters, Step Up Converters, Ideal Power Rectifiers		
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. Teaching is based on lectures. The course delivery will be based on theoretical lecturing, assignments and exercises solved in class. Exercises will be handed to students and their solutions shall be analysed at lecture periods. Additional tutorial time at the end of each lecture will be provided to students. Students are expected to demonstrate the necessary effort to become confident with the different concepts and topics of the course.
Bibliography	**(a) Textbooks:** • Rashid Muhammed H, ***Power Electronics-Circuits Devices and Applications***, Prentice Hall, 4th Edition, Prentice Hall, 2013. **(b) References:** • Rashid Muhammed H, ***Power Electronics Handbook - Devices, Circuits and Applications***, 2nd edition, Prentice Hall, 2006. • Rashid Muhammed H, ***Power Electronics Handbook***, Prentice Hall, 2009. • Harish C Rai, ***Textbook of Power Electronics Devices Circuits Systems & Applications***, Galgotia Publications Pvt Ltd, 2009.A.A.Harms,
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 and 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 30% • Mid-Term written exams 70% 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 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**