

Identification	Subject (code, title, credits)	ETR 580- Materials for Power Electronics 8 ECTS credits
	Department	Physics and Electronics
	Program (undergraduate, graduate)	Master
	Term	Fall 2026
	Instructor	Ahmad Asimov PhD
	E-mail:	fizikasimov@gmail.com
	Phone:	+994124211093 (daxili255)
	Classroom/hours	302N Monday/Wednesday
	Office hours	Tuesday: 15:00-16:00/ Thursday: 15:00-16:00
Prerequisites	No	
Language	English	
Compulsory/Elective	Elective	
Required textbooks and course materials	1. Principles and Elements of Power_Electronics Barry W Williams 2006. https://pddh.xaut.edu.cn/_local/E/25/14/F1132C9C735E6D8988EA0BDDDBFD_CFCDEBE7_22741F4.pdf 2. Muhammad H.Rashid. Power Electronics. Third edition, USA 2016. https://powerunit-ju.com/wp-content/uploads/2016/11/Book. 3. Power_Electronics_Handbook_3rd_Edition_M_Rashid.pdf 2 V.Ramanarayanan. Course on material on Switched mode power conversion. Indian Institute of science. 2008. E-book pdf Web pages: https://www.electrical4u.com/electrical-engineering-articles/power-electronics/#. 4. S. O. Kasap, "Optoelectronics and Photonics: Principles and Practices," Prentice-Hall, 2018	
Course description	Power electronics is the study of electronic circuits designed to control the flow of electrical energy. Electronic circuits control the flow of power at levels well above the rated characteristics of individual devices. In general, electronic engineering is the circuits that engineers design and use to convert energy. The goal of modern electronics is to solve problems of reliable and efficient energy. To do this, it is necessary to clarify how electronic circuits and systems can be used to solve problems of energy conversion and control. Course of Power Electronics includes the working principles of converters, inverters, and rectifiers, and their critical role in power electronic systems.	
Student Learning Objectives/Outcomes	What students should know by the end of the course: Fundamentals of Power electronics, working principle inverters and converters, structure of power circuit, master engineering logic, switching characteristics of SCR, about thyristor protection and gate characteristics, about IGBT and other power converters, such as buck and boost converters. Explain classification, properties and characteristics of electrical and electronic engineering materials. Analyses and predict future directions in the use of electronic materials and design of electronic devices. Understand and explain the fundamental principles underlying the operation of various electronic devices. Provide an introduction to the processing methods for materials used in the semiconductor industry. On successful completion of this course students will be able to: 1. Describe the characteristics of conducting and semiconducting materials 2. Classify and describe different insulators and to explain the behaviors of dielectrics in static and alternating fields 4. Solve simple problems based on dielectric, magnetic and conducting materials 5. Classify and describe Solar energy materials and superconducting materials 6. Discuss classification, properties and characteristics of different electrical engineering materials	
Teaching methods	Group discussion	☐
	Lecture	☐

Evaluation	Quiz, Classroom Exams		☐
	Date/deadlines		Percentage (%)
	Midterm Exam		30
	Activity	At each lesson	5
	Quizzes	During the semester, total 4 quizzes, for each 5 points	20
	Attendance	At each lesson	5
	Final Exam		40
	Total		100
Policy	▪ Preparation for class The structure of this course makes your individual study and preparation outside the class extremely important. The lecture material will focus on the major points introduced in the text. Reading the assigned chapters and having some familiarity with them before class will greatly assist your understanding of the lecture. After the lecture, you should study your notes and work relevant problems and cases from the end of the chapter and sample exam questions. • Withdrawal (pass/fail) This course strictly follows grading policy of the School of Science and Engineering. Thus, a student is normally expected to achieve a mark of at least 60% to pass. In case of failure, he/she will be required to repeat the course the following term or year. ▪ Cheating/plagiarism Cheating or other plagiarism during the Quizzes, Mid-term and Final Examinations will lead to paper cancellation. In this case, the student will automatically get zero (0), without any considerations. ▪ Generative AI Policy In this course, the use of Generative Artificial Intelligence (AI) tools is permitted to a limited extent. Students may use AI applications as supplementary learning resources, including to clarify course concepts, summarize information, develop study materials, create practice questions, and enhance their understanding of the subject matter. However, AI tools should not be used to generate or contribute answers for exams, midterms or final exams, assignments, projects, or any other form of grading, unless explicitly stated otherwise by the instructor. Students are solely responsible for the content they submit and must independently verify the accuracy, appropriateness, and reliability of the information generated by the AI tools. When AI tools are used for permitted purposes, students are expected to clearly and appropriately describe their use in accordance with the instructor's guidelines. ▪ Professional behavior guidelines The students shall behave in the way to create favorable academic and professional environment during the class hours. Unauthorized discussions and unethical behavior are strictly prohibited. ▪ Attendance Students who maintain full attendance for the duration of the course will be awarded 5 marks. Conversely, for every three absences recorded, the student will incur a deduction of 1 mark. ▪ Quizzes Four quizzes will be administered throughout the semester, with formal		

		announcements made in class two weeks prior to the assessment date. The content of each quiz is based on assigned homework problems, which are curated from the questions and problems at the end of each chapter. ▪ Activity Students who demonstrate active engagement during the review of previous lessons and proficiently solve problems during seminar sessions will be awarded one activity mark.	
Tentative Schedule			
Wee	Date/Day (tentative)	Topics	Textbook
1	18.09.2026 23.09.2026	Fundamentals of Power Electronics Materials Basic Semiconductor Physics and Technology. Classification of Power Electronics Materials. Scope of Electrical and Electronic Materials. Requirements of Engineering Materials	Chapter 1
2	25.09.2026 30.09.2026	Semiconductor Materials for Power Devices Semiconductors Materials: Basic Concept, type of semiconductors, working and applications of semiconductors. Different semiconducting materials used in manufacture of various semiconductor devices (MOSFET technologies and diodes). Wide bandgap semiconductor materials in power electronics	Chapter 2
3	02.10.2026 07.10.2026	Semiconductor Materials for Power Devices Semiconductors Materials: Basic Concept, type of semiconductors, working and applications of semiconductors. Different semiconducting materials used in manufacture of various semiconductor devices (MOSFET technologies and diodes). Wide bandgap semiconductor materials in power electronics	Chapter 3
4	09.10.2026 14.10.2026	Silicon materials and applications in Power Electronics Physical properties of silicon materials. Structural features. Chemical, mechanical and thermal features. Electronic and thermal features. Purifying silicon. Crystallinity.	Chapter 4
5	16.10.2026 21.10.2026	Silicon materials and applications in Power Electronics Single crystal silicon. Czochralski process. Multi-crystalline Silicon . Amorphous Silicon. Substrates and thin layers of Si. Technological steps for achieving power components.	Chapter 5
6	23.10.2026 28.10.2026	Silicon Carbide Applications in Power Electronics Physical properties of silicon carbide. Structural features. Chemical, mechanical and thermal features. Electronic and thermal features. Other “candidates” as semiconductors of power. State of the art technology for silicon carbide power components. Substrates and thin layers of SiC.	Chapter 6
7	30.10.2026 13.11.2026	Silicon Carbide Applications in Power Electronics Technological steps for achieving power components. Applications of silicon carbide in power electronics (MOSFETs, diodes). SiC components for high	Chapter 7

		frequency power supplies. SiC components for switching systems under high voltage and high power. High energy SiC components for series protection systems. Si and SiC physical and electrical properties compared	
8	18.11.2026	Gallium Nitride (GaN) materials and applications in Power Electronics. Properties of Gallium Nitride (GaN) materials. Structural features. Mechanical, electronic and thermal features. Substrates and thin layers of Gallium Nitride (GaN). Applications of Gallium Nitride (GaN) in power electronics (heteroepitaxy, HEMTs, high-frequency applications, diodes).	Chapter 8
		Midterm exam	
9	20.11.2026 25.11.2026	Materials for cooling of power switching semiconductor devices. Thermal resistances . Contact thermal resistance Thermal Interface Materials. Phase Change Gasket Materials (solid to liquid)	Chapter 9
10	27.11.2026 02.12.2026	Soft Magnetic Materials - Inductors and Transformers Inductor and transformer electrical characteristics Magnetic material types. Comparison of material types Ferrite characteristics. Power ferrite transformer design	Chapter 10
11	04.12.2026 09.12.2026	Hard Magnetic Materials - Permanent Magnet Magnetic properties. Classification of magnetic materials Properties of hard magnetic materials	Chapter 11
12	11.12.2026 16.12.2026	Materials And Devices For Energy Harvesting And Storage Primary Sources: Hydrocarbon attributes , The fuel cell, Materials and cell design (Electrodes, Catalyst, Electrolyte, Interconnect, Stack design), Fuel Cell Electrical characteristics.	Chapter 12
13	18.12.2026	Materials And Devices For Energy Harvesting And Storage Organic photovoltaic cell and organic electronic materials,	Chapter 13
14	23.12.2026	Secondary Sources: The lead-acid battery, The nickel-cadmium battery, The lithium-ion battery, Thermoelectric modules, Thermoelectric materials	Chapter 14
15	25.12.2026	Nanomaterials and composites in power electronics Introduction and properties, synthesis of nanomaterials, Carbon Nano Tubes, Quantum dots. Photonic crystals. Organic materials. Applications of nanomaterials in modern technology	Chapter 15
		Final exam	

