Identification	Subject (code, title, credits)	ETR 580- Materials for Power Electronics 8 ECTS credits	
	Department	Physics and Electronics	
	Program (undergraduate , graduate)	Graduate	
	Term	Fall 2025	
	Instructor	Ahmad Asimov ph.D	
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	Phone:	(daxili255)	
	Classroom/hours	302N Monday/Wednesday	
	Office hours	Tuesday: 15:00-16:00/ Thursday: 15:00-16:00	
Prerequisites			
Language	English		
Compulsory	Compulsory		
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/F1132C9C735E6D8988EA0BDDBFD_CFCDEBE7_22741F4.pdf Muhammad H.Rashid. Power Electronics. Third edition, USA 2016. https://powerunit-ju.com/wp-content/uploads/2016/11/Book. 2. 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/#. 3. S. O. Kasap, "Optoelectronics and Photonics: Principles and Practices," *Prentice-Hall,*		
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: Fundamentdals of Power elctronics, working principle inverters and converters, srtucture of power circuit, master engineering logic, swithcing characteristics of SCR, about thyristor protection and gate characteristics, about IGBT and other power converters, sucah as buck and boost converters. Explain classification, properties and characteristics of electrical and electronic engineering materials. Analyse and predict future directions in the use of electronic materials and design of electronic devices. Anderstand 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 Evaluation	**Lecture**		+
	Group discussion		+
		Date/deadlines	**Percentage (%)**
Evaluation	Midterm Exam		30
	Activity	At each lesson	5
	Quizzes	2 times during the semester	20
	Presentation	During the semester	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. **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. **Quizzes** • There will be a quiz examination per two weeks. The quizzes will be announced in the classroom two weeks before. Quiz is from homework problems. • The homework problems will be selected from questions and problems in the end of each chapter. The No. of homework problems will be announced after finishing each chapter. **Presentation** • There will be a presentation per two weeks. The presentation works will be announced in the classroom two weeks before and will relate to homework. **Activity** • Students who will be active during discussion of past lessons will be awarded with one activity mark.

Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook
1	18.09.2025 23.09.2025	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 [1] p. 1-30
2	25.09.2025 30.09.2025	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 [1] p. 31-80
3	02.10.2025 07.10.2025	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 [1] p. 81-160

4	09.10.2025 14.10.2025	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 [1] p. 161-220
5	16.10.2025 21.10.2025	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 [1] p. 221-330
6	23.10.2025 28.10.2025	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 [1] p. 331-410
7	30.10.2025 13.11.2025	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 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	Chapter 7 [1] p. 411-460
8	18.11.2025	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 [1] p. 461-520
		Midterm exam	
9	20.11.2025 25.11.2025	Materials for cooling of power switching semiconductor devices Thermal resistances Contact thermal resistance Thermal Interface Materials Phase Change Gasket Materials (solid to liquid)	Chapter 1 [2] p. 1–40
10	27.11.2025 02.12.2025	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 2 [2] p. 41–96
11	04.12.2025 09.12.2025	Hard Magnetic Materials - Permanent Magnet Magnetic properties Classification of magnetic materials Properties of hard magnetic materials	Chapter 3 [2] p. 97–160
12	11.12.2025 16.12.2025	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 4 [2] p. 161–220
13	18.12.2025 23.12.2025	Materials And Devices For Energy Harvesting And Storage Organic photovoltaic cell and organic electronic materials, Secondary Sources: The lead-acid battery, The nickel-cadmium battery, The lithium-ion battery, Thermoelectric modules, Thermoelectric materials	Chapter 5 [2] p. 221–280
14	25.12.2025	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 6 [2] p. 281–380
		Final exam	