Identification	**Subject**	ETR 211 Semiconductor Devices- 6 ECTS credits
	Department	Physics and Electronics
	Program	Undergraduate
	Term	Fall 2024
	Instructor	Ph.D. Shirkhan Humbatov
	E-mail:	shirxanhumbatov@gmail.com
	Phone:	+99477-631 32 83
	Classroom/hours	08:30-15:35
	Office hours	
Prerequisites	no	
Language	English	
Compulsory/Elective	(elective major)	
Description	The "Semiconductor Devices" course explores the fundamental principles of semiconductors and their applications in modern electronics. It covers topics such as diode operation, transistors, and the behavior of charge carriers in semiconductor materials. Students will learn to analyze and design electronic circuits using these devices, with a focus on their role in integrated circuits and communication systems.	
Required textbooks and course materials	Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen	
Course website	https://en.wikipedia.org/wiki/Semiconductor_device https://byjus.com/physics/semiconductor-devices/ https://toshiba.semicon-storage.com/ap-en/semiconductor/knowledge/e-learning/discrete/chap1/chap1-7.html https://www.youtube.com/watch?v=hCQSO8BmGWw https://www.youtube.com/watch?v=XKQb_Q0KHOU	
Course outline	The Semiconductor Devices course provides a comprehensive understanding of the principles and applications of semiconductor materials and devices, which are essential in modern electronics. The course begins with an introduction to semiconductor physics, covering energy bands, charge carriers, and the intrinsic and extrinsic properties of materials like silicon and germanium. It then explores PN junction diodes, their characteristics, and applications such as rectifiers and voltage regulators. Bipolar junction transistors (BJTs) are introduced next, focusing on their operation modes and use in amplification and switching circuits. The course also covers field-effect transistors (FETs), including MOSFETs and JFETs, emphasizing their importance in digital circuits and power management. Further, students examine optical devices such as light-emitting diodes (LEDs) and photodiodes, as well as power semiconductor devices like thyristors and IGBTs, which are used in high-power applications. Semiconductor fabrication techniques are also discussed, providing insight into the manufacturing process of these devices. The course emphasizes both theoretical understanding and practical applications, equipping students with the skills needed to analyze and design semiconductor-based circuits. Finally, emerging technologies such as nanotechnology and organic semiconductors are briefly introduced, showcasing future trends in the field.	
Course objectives	The objective of the Semiconductor Devices course is to provide students with a deep understanding of the physical principles and operational mechanisms of semiconductor materials and devices. This course aims to equip students with the ability to analyze and design basic semiconductor components such as diodes, transistors, and integrated circuits. It emphasizes the importance of semiconductors in modern electronics, explaining their role in enabling advancements in technology. The course will foster students' ability to interpret semiconductor characteristics and performance parameters through both theoretical and practical approaches. A key goal is to enhance problem-solving skills by applying semiconductor concepts to real-world engineering challenges. Additionally, students will gain hands-on experience through lab work, where they will simulate and test semiconductor devices. The course also introduces students to emerging technologies, such as microelectronics and nanotechnology, emphasizing the evolving landscape of semiconductor applications. By the end of the course, students should be able to understand the design and function of semiconductor devices in electronic systems. Overall, the course strives to build a strong foundation for further study and research in electronics, nanotechnology, and related fields.	
Learning outcomes	The subject of semiconductor devices equips students with an understanding of the fundamental principles and applications of semiconductors in modern electronics. Upon completing the course, students will: 1. Gain a solid understanding of semiconductor materials and their properties, including energy bands, carrier concentration, and doping. 2. Be able to explain the operation of key semiconductor devices such as diodes, transistors, and field-effect transistors (FETs). 3. Develop proficiency in analyzing and designing circuits that incorporate semiconductor devices for various electronic applications. 4. Understand the role of semiconductors in optoelectronic devices like LEDs and	

	photodiodes. 5. Learn how to model the electrical characteristics of semiconductor devices using appropriate equations and simulations. 6. Acquire skills in evaluating device performance, including breakdown voltage, current-voltage characteristics, and thermal behavior. 7. Understand the role of semiconductors in modern technology, including their use in integrated circuits (ICs) and microprocessors. 8. Be familiar with fabrication techniques for semiconductor devices, including lithography and doping processes. 9. Develop problem-solving abilities related to the optimization of semiconductor device performance in specific applications. 10. Be prepared for advanced study or careers in electronics, materials science, or related fields where semiconductor devices play a crucial role.		
Teaching methods	**Lecture**		+
	Seminar		+
	Assisted work		x
	Assisted lab work		x
	Others		
Evaluation	**Methods**	**Date/deadlines**	**Percentage (%)**
	Midterm Exam		30
	Class Participation and Attendance	At each lesson	5
	Quizzes	During the semester, total 2 quizzes, for each 10 points	20
	Activity	At each lesson	10
	Final Exam		35
	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 pointsintroduced in the text. Reading the assigned chapters and having some familiaritywith them before class will greatly assist your understanding of the lecture. Afterthe 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 least60% to pass. In case of failure, he/she will be required to repeat the course thefollowing 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.

  Attendance
  Students who attend the whole classes will get 5 marks. for three absence student loses 1 mark.

- **Activity**
  Students who will be active during discussion of past lessons and who will be solve homework problems in a seminar will be awarded with one activity mark.
- **Quizzes**
- There will be 2 quizzes examination during the semester. The quizzes will be announced in the classroom two weeks before. Quiz is based on homework problems. The homework problems will be selected from questions and problems in the end of each chapter. The number of homework problems will be announced after finishing each chapter.

- The students who able to pass midterm and first quiz with max points automatically get max 10 point for the second quiz.

Tentative Schedule			
Week	**Date/Day (Tentative)**	**Topics**	**Textbook/Assignments**
1	**16.09.24-21.09.24**	**Introduction to Semiconductors** • Overview of semiconducting materials • Intrinsic and extrinsic semiconductors • Energy band structures	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
2	**23.09.24-28.09.24**	**Charge Carriers in Semiconductors** • Electrons and holes • Carrier concentration • Fermi levels and distribution functions	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
3	**30.09.24-05.10.24**	**Carrier Transport Mechanisms** • Drift and diffusion of charge carriers • Mobility and conductivity • Continuity equation and recombination processes	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
4	**07.10.24-12.10.24**	**PN Junction Diodes** • Formation and characteristics of PN junctions • Current-voltage characteristics • Breakdown mechanisms and Zener diodes	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
5	**14.10.24-19.10.24**	**Metal-Semiconductor Contacts** • Schottky and ohmic contacts • Energy band diagrams • Applications of Schottky diodes	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
	21.10.24-26.10.24	**Bipolar Junction Transistors (BJTs)** • Structure and operation of BJTs • Current gain and regions of operation • BJT switching and amplification	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
7	**28.10.24-02.11.24**	**Field-Effect Transistors (FETs)** • Types of FETs: JFET, MOSFET • Channel formation and current flow • MOSFET I-V characteristics 	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
8	**04.11.24-09.11.24**	**MOS Capacitors and C-V Characteristics** • MOS structure and operation • Capacitance-voltage characteristics • Flat-band voltage and threshold voltage	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
9	**11.11.24-16.11.24**	**Quiz** **Problem solving**	

10	**18.11.24-23.11.24**	**MOSFET Scaling and Short Channel Effects** • MOSFET scaling principles • Subthreshold conduction and DIBL • High-k dielectrics and metal gates	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
11	**25.11.24-30.11.24**	**Power Semiconductor Devices** • Power diodes, thyristors, and IGBTs • Switching characteristics and applications • Thermal management and reliability	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
12	**02.12.24-07.12.24**	**Optoelectronic Devices** • Photodiodes and solar cells • Light-emitting diodes (LEDs) • Laser diodes	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
13	**09.12.24-14.12.24**	**Semiconductor Device Fabrication Techniques** • Doping, oxidation, and photolithography • Etching, deposition, and metallization • CMOS process technology	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
14	**16.12.24-21.12.24**	**Noise in Semiconductor Devices** • Types of noise: thermal, shot, and flicker noise • Noise sources in diodes, BJTs, and MOSFETs • Techniques for noise reduction	• Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen • Handnotes given by teacher
15	**23.12.24-28.12.24**	**Emerging Semiconductor Devices** • Wide bandgap semiconductors (GaN, SiC) • Tunnel FETs, FinFETs, and nanoscale devices Applications in power electronics and quantum devices	1. Semiconductor Physics and Devices Basic Principles Fourth Edition Donald A. Neamen 2. Handnotes given by teacher
		Final Exam