Identification	Subject (code, title, credits)	ETR 545 Semiconductor devices and technology-8 ECTS credits	
	Department	Physics and Electronics	
	Program (undergraduate, graduate)	Master	
	Term	2024 fall	
	Instructor	Ahmad Asimov Ph.D.	
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	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. James M. Fiore Semiconductor Devices: Theory and Application 2. Physics of Semiconductor Devices, 2nd edition, S. M.Sze, John Wiley&Sons, 3. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. 4. S. O. Kasap, "Optoelectronics and Photonics: Principles and Practices," *Prentice-Hall,*		
Course description	This course will cover the physics of semiconductor devices (charge carriers, doping, conductivity and mobility), which will help you to understand PN junctions LEDs, Solar cells, Photodetectors Bipolar Transistors, Schottky diodes, MOS Capacitors, and MOSFETs. Laboratory exercises will be completed in conjunction with classroom lectures, individual study, and homework.		
Student Learning Objectives/Outcomes	The course will enable students to understand and appreciate the synergy between quantum mechanics and semiconductor materials, which will eventually lead to a general framework of concepts applicable across a variety of semiconductor devices. Upon completion of the course, the student should be able to 1. Explain the different types of Semiconductor Diodes and their Specifications 2. Learn the important concepts related to semiconductor technology. 3. Perform the analysis and design of semiconductor devices (electrostatics and current-voltage characteristics) from fundamental principles. 4. Learn how to extract device parameters by suitable experiments. 5. Extend the concepts and analysis to advanced topics such as: devices based on disordered semiconductors (e.g. organic semiconductors, amorphous metal oxides), flexible and printed electronics, etc. 6. Analyze the transistor operation under different configurations and application of Transistor as an Amplifier 7. Explain the Constructional features and operation of different types of FET 8. Solve simple problems and develop circuits using Semiconductor Devices for simple electronic circuit applications		
Teaching methods	**Lecture**		
Teaching methods Evaluation	**Group discussion**		☐
	Experiential exercise		☐
	Quiz, Classroom Exams		☐
		Date/deadlines	**Percentage (%)**
Evaluation	**Midterm Exam**		30
	Active participation	During the semester	5
	Quizzes	4 quizzes during the semester	20
	Activity	Each lesson	5
	Final Exam	During the semester	40
	Others		
	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. ▪ **Attendance** Students who attend the whole class will get 5 marks. for three absence student loses 1 mark. ▪ **Active participation** Students who will be active during discussion of past lessons and who will solve homework problems in a seminar will be awarded with one activity mark.

Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook
1	16.09.24	Excursion in Quantum Mechanics. Crystal structure of solids; space lattices; wave particle duality; Schrodinger's wave equation; particle trapped in a box	Chapter 1
	16.09. 24	Semiconductors: Energy Band and Charge Carriers: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials.	
2	23.09.24	A visual introduction to semiconductors.	Chapter 2
	23.09.24	Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration. Conductivity and mobility,	
3	30.09.24	PN Junction Diode: PN junction electrostatics, equilibrium and depletion approximation, Energy band diagrams. Reverse bias transition capacitance and breakdown in PN junctions.	Chapter 3
	07.10.24	Analysis of diodes with multimeters	
4	14.10.24	PN junction under forward bias, minority carrier injection, DC current-voltage characteristics, and Temperature effect. Non-ideal diodes, tunneling diodes, AC Analysis, charge storage and transient characteristics, applications. I-V characteristics and non-idealities,	Chapter 4

	14.10.24	the volt-ampere characteristic of a diode	
5	21.10.24	Capacitance of p-n junction, Schottky barriers; Schottky barrier height, C-V characteristics, current flow across Schottky barrier: thermionic emission, Rectifying contact and Ohmic contact. heterostructures,	Chapter 5
	28.10.24	The volt-ampere characteristic of a diode	
6	04.11.24	Diode Applications Half-wave Rectification A Note Regarding Transformers Smoothing (Filtering) the Output Full-wave Rectification Full-wave Bridge With Dual Outputs Zener Regulation	Chapter 6
	11.11.24	Experiment	
7	18.11.24	**Midterm exam**	
8	25.11.24	Field Effect Transistors: JEFT amplifying and switching, Pinch off and saturation, Gate control, I-V characteristics. MOSFET, Operation, MOS capacitor,	Chapter 7
	25.11.24	experiment	
10	02.12.24	Work function difference, Interface charge, Threshold voltage and its control, MOS C-V analysis and time dependent capacitance. Output and transfer characteristics of MOSFET.	Chapter 8
	02.12.2024	Experiment	
11	09.12.24	Bipolar Junction Transistors (BJT): Fundamentals of BJT operation. Minority carrier distribution, Solution of diffusion equation in base region,	Chapter 9
	09.12.24	Terminal current, Current transfer ratio, Ebers-Moll equations, Charge control analysis. BJT switching: Cut off, Saturation, Switching cycle	Chapter 10
12	16.12.24	Photonics: LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photodetectors: Ideal conversion efficiency, Fill factor	Chapter 11
	23.12.24	Experiment	
13	30.12.24	Semiconductor technology Epitaxy. Thermal oxidation. Photolithography. Semiconductor manufacturing technologies.	Chapter 12
	30.12.24	Functional electronics. Organic semiconductor materials and application.	
		Final exam