Identification	**Subject (Code, title, credits)**	ETR 211 Semiconductor devices and technology 6 ECTS credits	
	Department	Physics and Electronics	
	Program (undergraduate graduate)	undergraduate	
	Term	2023 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. Solid State Electronic Devices, B. G. Streetman, S. K. Banerjee, 5th or 6th Edition, Prentice Hall, 2006. 2. Semiconductor Device Fundamentals, R. F. Pierret, Addison Wesley, 1996 3. James M. Fiore Semiconductor Devices: Theory and Application 4. Physics of Semiconductor Devices, 2nd edition, S. M.Sze, John Wiley&Sons, 5. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. 6. 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 pin junctions LEDs, Photodetectors, Bipolar Transistors, Schottky diodes and MOSFETs. This course will also cover the general principle of Solar cells, LEDs, Photodetectors (applications of PN junction). Laboratory exercises will be completed in conjunction with classroom lectures, individual study, and homework.		
Course objectives	The purpose of the subject "Semiconductor Devices and Modeling" is to teach students about the electrical and optical properties of semiconductors, identifying the main differences between semiconductors, dielectrics, and metals. Semiconductor devices and modeling course provides general information about charge carriers in semiconductors, electrical conductivity, diffusion of charge carriers, band structure, additive semiconductors, semiconductor-based ideal diode, p-n junction, volt-ampere characteristic of diode, their applications, including rectifier the working principle of the elements is investigated. In addition to these, one of the goals of the course is to provide information about the characterization and experimental methods of semiconductors and devices made of materials. The course also analyzes the structure of the transistor, the distribution of loads and potentials, its study in the quadrupole model, the structure and working principle of the field-effect transistor, switching and output VAX assemblies.		
Student Learning Outcomes	Upon completion of the course, the student should be able to: ▪ Explain the different types of Semiconductor Diodes and their Specifications. ▪ Learn the important concepts related to semiconductor technology. ▪ Perform the analysis and design of semiconductor devices (electrostatics and current-voltage characteristics) from fundamental principles. ▪ Learn how to extract device parameters by suitable experiments. ▪ Extend the concepts and analysis to advanced topics such as: devices based on disordered semiconductors (eg. organic semiconductors, amorphous metal oxides), flexible and printed electronics, etc. ▪ Analyze the transistor operation under different configurations and application of Transistor as an Amplifier ▪ Explain the Constructional features and operation of different types of FET		
Teaching methods	**Lecture**		
Teaching methods Evaluation	**Group discussion**		+
	Experiential exercise		+
	Quiz, Classroom Exams		+
	Date/deadlines		**Percentage (%)**
Evaluation	**Midterm Exam**		30
	Active participation	At each lesson	5
	Quizzes	4 quizzes during the semester	20
	Activity	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 a way to create a 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. **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	16.09.23	Course introduction, solid-state electronic materials, bonding forces, and energy bands in solids	Chapter 1
	16.09. 23	Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials.	
2	23.09.23	A visual introduction to semiconductors.	Chapter 2
	23.09.23	Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration. Conductivity and mobility,	
3	30.09.23	PN junction electrostatics, equilibrium and depletion approximation, Energy band diagrams. Reverse bias transition capacitance and breakdown in PN junctions.	Chapter 3
	07.10.23	Analysis of diodes with multimeters	
4	14.10.23	PN junction under forward bias, minority carrier injection, DC current-voltage characteristics, and Temperature effect. Diode I-V characteristics and non-idealities,	Chapter 4
	14.10.23	the volt-ampere characteristic of a diode	
5	21.10.23	Schottky barriers; Schottky barrier height, C-V characteristics, current flow across Schottky barrier: thermionic emission, Rectifying contact and Ohmic contact.	Chapter 5
	28.10.23	the volt-ampere characteristic of a diode	
6	04.11.23	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
	11.11.23	experiment	
7	18.11.2023	Midterm exam	
8	25.11.23	Field Effect Transistors: JEFT amplifying and switching, Pinch off and saturation, Gate control, I-V characteristics. MOSFET, Operation, MOS	Chapter 7

		capacitor,	
	25.11.2023	experiment	
10	02.12.2023	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
	02.12.2023	experiment	
11	09.12.2023	Bipolar Junction Transistors (BJT): Fundamentals of BJT operation. Minority carrier distribution, Solution of diffusion equation in base region,	Chapter 9
	09.12.2023	Terminal current, Current transfer ratio. BJT switching: Cut off, Saturation, Switching cycle	Chapter 10
12	16.12.2023	Photonics: LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell, and photodetectors.	Chapter 11
	23.12.2023	Experiment	
13	30.12.23	Semiconductor technology Epitaxy. Thermal oxidation. Photolithography. Semiconductor manufacturing technologies.	Chapter 12
	30.12.2023	Functional electronics	
		Final exam