ABDULLAH GÜL UNIVERSITY
GRADUATE SCHOOL OF ENGINEERING & SCIENCE
ELECTRICAL AND COMPUTER ENGINEERING PROGRAM
COURSE DESCRIPTION AND SYLLABUS

Course Title	Code	Semester	T+L Hours	Credit	ECTS
SEMICONDUCTOR DEVICE FUNDAMENTALS	ECE-516	FALL-SPRING	3 + 0	3	10

Prerequisite Courses	None

Type	Selective
Language	English
Coordinator	Assist. Prof. Dooyoung Hah
Instructor	Assist. Prof. Dooyoung Hah
Adjunt	None
Aim	Detailed coverage of semiconductor materials, band theory, statistics, p-n junction, metal-semiconductor junction, transistors, optoelectronic devices
Learning Outcomes	To provide an opportunity for students to • learn the basic properties of semiconductors, including crystal structure, band structure, carrier statistics, and carrier transport and recombination phenomena • learn the operation principles of p-n junction diodes, including current-voltage characteristics and charge storage • learn the properties of metal-semiconductor contacts and their applications • learn the operation principles of MOSFETs • learn the operation principles of bipolar junction transistors • learn the operation princples of optoelectronic devices such as photodiodes, LEDs and solar cells
Course Content	• Semiconductor crystal structure, • Energy-band model of solid, • Carrier statistics, • Principles of p-n junction, • Properties of metal-semiconductor contacts, • Operation principles of MOSFETs, • Fundamentals of bipolar junction transistors, • Working principles of optoelectronic devices

WEEKLY TOPICS AND PRELIMINARY STUDY

Week	Topic	Preliminary Study
1	Semiconductor crystal structure: Space lattices, semiconductor lattices, miller indices	The relevant articles from the literature
2	Energy-band model of solid: Quantization concept, application of Schrodinger wave equation, energy band model, energy band gap	The relevant articles from the literature
3	Carrier statistics: Effective mass, density of states, statistical mechanics, Fermi level, equilibrium distribution of electrons and holes, statistics of donors and acceptors	The relevant articles from the literature
4	p-n junction: Electrostatics, built-in potential, quantitative electrostatic relationships, linearly graded junctions	The relevant articles from the literature
5	p-n junction: Ideal diode equation, reverse bias breakdown, recombination-generation current, high-current phenomena, narrow-base diode, capacitance-voltage relationships	The relevant articles from the literature
6	MIDTERM EXAM	The relevant articles from the literature
7	Metal-semiconductor contacts: ideal MS contacts, schottky diode, current-voltage characteristics, transient response	The relevant articles from the literature
8	MOSFETs: Electrostatics, effect of an applied bias, capacitance-voltage characteristics	The relevant articles from the literature
9	MOSFETs: Current-voltage relationships, threshold voltage, metal-semiconductor workfunction difference	The relevant articles from the literature
10	MOSFETs: ac response, small-signal equivalent circuits, oxide charges, short-channel effect	The relevant articles from the literature
11	Bipolar junction transistors: Electrostatistics, emitter efficiency, base transport factor, common base dc current gain, common emitter dc current gain	The relevant articles from the literature
12	MIDTERM EXAM	The relevant articles from

		the literature
13	Bipolar junction transistors: Ideal transistor analysis, Ebers-Moll equations, base-width modulation, avalanche multiplication and breakdown, recombination-generation current	The relevant articles from the literature
14	Optoelectronic devices: pn junction photodiodes, p-i-n photodiodes, avalanche photodiodes, solar cells	The relevant articles from the literature
15	Optoelectronic devices: light emitting diodes, laser diodes	The relevant articles from the literature
16	Final Exam	

SOURCES	
Lecture Notes	Lecture slides
Other Sources	**Course Textbook:** "Semiconductor device fundametals," R. F. Pierret, 1996, Prentice Hall. **Additional Materials:** 1. "Semiconductor physics and devices," D. A. Neamen, 2012, McGraw-Hill. 2. "Physics of semiconductor devices," S. M. Sze and K. K. Ng, 2007, Wiley-Interscience

COURSE MATERIALS SHARING	
Documents	Lecture notes and slides
Homeworks	Students will be given one homework in every two weeks
Exams	2 Midterms and 1 Final Exam

EVALUATION SYSTEM		
SEMESTER STUDY	**NUMBER**	**CONTRIBUTION**
Midterm	2	40
Homework	8	10
Semester project	1	20
SUB-TOTAL		70
Contribution of Semester Study		70
Contribution of Final Exam	1	30
TOTAL		100

Course Category	
Sciences and Mathematics	20%
Engineering	80%
Social Sciences	0%

RELATIONSHIPS BETWEEN LEARNING OUTCOMES AND PROGRAM QUALIFICATIONS							
No	Program Qualifications	Contribution Level				
		1	2	3	4	5
1	The skills of using mathematics, science and engineering information in advanced research					**X**
2	The skills of analyzing, designing and/or implementing an original system that will be able to solve an engineering problem			**X**		
3	The skills of using the required software, hardware and modern measurement equipments in their field of research					**X**
4	The skills of planning independent research and implementing in detail					**X**
5	The skills of following literature, listening to and making technical presentation, writing a paper in academic level				**X**	
6	The skills of innovative and interrogative thinking and finding original solutions					**X**

*Increasing from 1 to 5.

ECTS / WORK LOAD TABLE			
Activities	Number	Duration (Hours)	Total Work Load

Course Length (includes exam weeks: 16x total course hours)	16	3	48
Out-of-class Study Time (Pre-study, practice)	16	2	32
Internet search, library work, literature search	16	1	16
Semester project	1	20	20
Homework	8	2	16
Midterm	2	30	60
Final Exam	1	33	33
Total Work Load			225
Total Work Load / 30			225/30
Course ECTS Credit			7.5