COURSE INFORMATON					
Course Title	*Code*	*Semester*	*C +P + L Hour*	*Credits*	*ECTS*
MOS Device Physics and Technology	EE535	Spring	3 + 0 + 0	3	10

Prerequisites	None

Language of Instruction	English
Course Level	Master's
Course Type	Elective
Course Coordinator	Uğur Çilingiroğlu
Instructors	Uğur Çilingiroğlu
Assistants	
Goals	Familiarizing the student with the MOSFET modeling constraints emanating from solid-state physics; presenting simultaneous solutions to the Poisson's equation and current and continuity equations under these constraints; applying the outcome to modeling the static and dynamic aspects of MOSFET operation; and, deriving guidelines for the structural optimization of MOSFET structures.
Content	Fundamental concepts and equations. Thermal equilibrium. Nonequilibrium. Basic MOSFET structure. MOSFET under bias. Fundamentals of structural optimization. Secondary effects. MOSFET dynamics.

Learning Outcomes	**Program Outcomes**	**Teaching Methods**	**Assessment Methods**
1) Familiarity with the most general solid-state device equations, and ability to solve them with appropriate boundary conditions; namely, Poisson's equation, current equations, and continuity equations,	3,5,6,7	1,2	A
2) Mastery of MOSFET structure,	5,7	1,2	A
3) Acquisition of design skills for optimizing the MOSFET structure,	3,4,6,7	1,2	A
4) Familiarity with the secondary effects in MOSFET operation,	5,6,7	1,2	A
5) Mastery of MOSFET dynamic operation.	5,6,7	1,2	A

Teaching Methods:	1: Lecture, 2: Problem Solving, 3: Simulation, 4: Seminar, 5: Laboratory, 6: Term Research Paper
Assessment Methods:	A: Exam, B: Quiz, C: Experiment, D: Homework, E: Project

COURSE CONTENT		
Week	**Topics**	**Study Materials**
1	Constituents of a semiconductor crystal. Poisson's equation.	Textbook
2	Current equations. Continuity equations. Energy-band diagrams	Textbook
3	Equilibrium properties of semiconductors. Analysis in equilibrium.	Textbook
4	Injection level. Shockley-Read-Hall theory of trapping. Analysis of bulk regions. Extending Fermi formalism to nonequilibrium.	Textbook
5	Basic MOSFET structure.	Textbook
6	Fundamentals of nonequilibrium analysis. Analysis of surface space-charge regions.	Textbook
7	A general strong-inversion model.	Textbook
8	Simplified strong-inversion models.	Textbook
9	Subthreshold model.	Textbook
10	p-channel MOSFET	Textbook
11	Velocity saturation. Channel-length modulation. Punch-through.	Textbook
12	Short-channel and narrow-channel effects.	Textbook
13	Impact ionization and avalanche breakdown.	Textbook
14	MOSFET dynamics.	Textbook

RECOMMENDED SOURCES	
Textbook	*Systematic Analysis of Bipolar and MOS Transistors*, Ugur Cilingiroglu, Artech House, Boston, 1993.
Additional Resources	

MATERIAL SHARING
Documents
Assignments
Exams

ASSESSMENT		
IN-TERM STUDIES	**NUMBER**	**PERCENTAGE**
Midterm I	1	25/50

Midterm II		1	25/50
Homework Assignment			
	Total		**50/50**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE			50
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE			50
	Total		**100**

COURSE CATEGORY	Field Course

COURSE'S CONTRIBUTION TO PROGRAM

No	Program Learning Outcomes	Contribution				
		1	2	3	4	5
1	Can reach information in breadth and depth, and can evaluate, interpret and apply this information to scientific research in the area of Electrical and Electronics Engineering.	√				
2	Can complete and apply information with scientific methods using limited or missing data; can integrate information from different disciplines.	√				
3	Sets up Electrical and Electronics Engineering problems, develops and implements innovative methods for their solutions.		√			
4	Develops new and/or original ideas and methods; finds innovative solutions to the system, component, or process design.		√			
5	Has comprehensive knowledge about the state-of-the-art techniques and methods in Electrical and Electronics Engineering and their limitations.				√	
6	Can design and conduct research of analytical, modeling or experimental orientation; can solve and interpret complex cases that come up during this process.				√	
7	Can communicate verbally and in writing in one foreign language (English) at the General Level B2 of the European Language Portfolio.					√
8	Can assume leadership in multi-disciplinary teams; can develop solutions in complex situations, and take responsibility.	√				
9	Can systematically and openly communicate in national and international venues the proceedings and conclusions of the work he/she performs in Electrical and Electronics Engineering.	√				
10	Respects social, scientific and ethical values in all professional activities performed during the collection, interpretation and announcement phases of data.	√				
11	Is aware of new and emerging applications in Electrical and Electronics Engineering; investigates and learns them, whenever necessary.	√				
12	Can identify the social and environmental aspects of Electrical and Electronics Engineering applications.	√				

ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION

Activities	Quantity	Duration (Hour)	Total Workload

			(Hour)
Course Duration (including 2 midterms: 14xtotal lecture hours)	14	3	42
Hours for off-the-classroom study (Pre-study, practice)			196
Midterm I	1	2	2
Midterm II	1	2	2
Homework assignment			
Final examination	1	2	2
Total Work Load			244
Total Work Load / 25 (h)			9.76
ECTS Credit of the Course			10