COURSE INFORMATON					
Course Title	*Code*	*Semester*	*C +P + L Hour*	*Credits*	*ECTS*
Analog Integrated Circuit Design	EE539	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	Teaching the techniques of (a) selecting an opamp or OTA topology appropriate for a specified application, (b) converting the open-loop performance metrics of the selected topology into individual device performance metrics, (c) optimum device sizing and biasing, and (d) verifying the design outcome by simulation.
Content	Current sources, sinks and mirrors. Current and voltage references. Basic amplifier stages. Basic OTA. Symmetrical OTA. Folded-cascode OTA. Miller OTA. Opamp with a push-pull source-follower output stage. Opamp with a push-pull common-source output stage. Fully differential OTAs and opamps.

Learning Outcomes	**Program Outcomes**	**Teaching Methods**	**Assessment Methods**
1) Mastery of the main OTA and opamp topologies, and their subcircuits.	1,5,11	1,2,3	A
2) Ability to convert open-loop performance metrics into device metrics.	2,3,6	1,2,3	A
3) Ability to size and bias OTA and opamp devices.	2,3,6	1,2,3	A
4) Mastery of running simulations for verifying analog integrated circuit design outcomes.	3,5,6	1,2,3	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	Current sources sources, sinks and mirrors.	Textbook
2	Current sources sources, sinks and mirrors.	Textbook
3	Current and voltage references.	Textbook
4	Basic amplifier stages.	Textbook
5	Basic amplifier stages.	Textbook
6	Basic OTA.	Textbook
7	Symmetrical OTA.	Textbook
8	Folded cascode OTA.	Textbook
9	Miller OTA.	Textbook
10	Opamp with a push-pull source-follower output stage.	Textbook
11	Opamp with a push-pull common-source output stage.	Textbook
12	Fully differential OTAs and opamps.	Textbook
13	Fully differential OTAs and opamps.	Textbook
14	Design examples.	Textbook

RECOMMENDED SOURCES	
Textbook	*Analog Integrated Circuit Design by Simulation*, Uğur Çilingiroğlu, McGraw-Hill Education, New York, 2019.
Additional Resources	Ngspice circuit simulator, http://ngspice.sourceforge.net/

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