TECHNISCHE HOCHSCHULE LÜBECK

Module: Analog Integrated Circuits

Level	Master	**Short Name**	AIS
Responsible Lecturers	Milady, Saeed, Prof. Dr.		
Department, Facility	Electrical Engineering and Computer Science		
Course of Studies	Applied Information Technology, Master		
Compulsory/elective	Compulsory elective	**ECTS Credit Points**	5
Semester of Studies	1	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	150
Frequency	SuSe	**Presence Hours**	60
Teaching Language	German/English	**Self-Study Hours**	90

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Project Work	**Exam Language**	German/English
Exam Length (minutes)		**Exam Grading System**	One-third Grades

Learning Outcomes	• The students know the real characteristics of MOS transistors. • Students can analyze and design the basic CMOS amplifier circuits (CS, CD, CG, etc.). • The students are familiar with the CMOS current sources and their corresponding biasing circuits. They can analyze and design them. • Students know the CMOS current sources analyze and design. • Students are familiar with CMOS differential amplifiers and can analyze and design them. • Students are familiar with various operational amplifier circuits (Miller OpAmp, Folded Cascode, RailtoRail Opamp, Constant gm, etc.) analyze them. • Students will be able to design a simple operational amplifier, simulate its important parameters and optimize them. • Students will be familiar with other typical integrated analog circuits (such as Bandgap reference, LDO, etc.) and their applications. • The students can verify their own circuit designs and their dimensioning in simulation. • Students will be able to layout simple analog circuits.
Participation Prerequisites	Analoge Elektronik, Grundlagen der Bauelemente und Elektronik

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✔ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)

Applicability	
Remarks	

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Analog Integrated Circuits (Lecture)

(of Module: Analog Integrated Circuits)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	3
Group Size		**Workload (hours)**	90
Teaching Language	German/English	**Presence Hours**	45
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	45
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	1. Introduction to MOS device physics 2. Single stage amplifiers (CS, CG, CD, cascade amplifiers) 3. Differential amplifiers 4. Current mirror 5. Frequency response of amplifiers and analog circuits (stability and frequency compensation) 6. Multistage operational amplifiers 7. Output stages (class AB/push pull, etc.) 8. Analog layout 9. Noise in analog circuits
Literature	1. Razavi, B., Design of Analog CMOS Integrated Circuits, McGrawHill, 2nd Edition, 2017. 2. Sedra, Adel S, et. al, Microelectronic circuits, 8th edition. New York, NY, Oxford: Oxford University Press, 2020. 3. Baker, J., CMOS: Circuit Design, Layout, and Simulation (IEEE Press Series on Microelectronic Systems), 2010
Remarks	

Module Course: Analog Integrated Circuits (Practical Training)

(of Module: Analog Integrated Circuits)

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	1
Group Size	12	**Workload (hours)**	60
Teaching Language	German/English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	45
SL Length (minutes)		**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	The following circuits are simulated using a professional circuit simulator using realistic submicron CMOS transitor models: 1. Basic CMOS transistor amplifier 2. Current sources, differential amplifiers 3. Operational amplifier
Literature	See lecture and script
Remarks	