

# Analog CMOS Integrated Circuits

Programme course

6 credits

Analoga CMOS integrerade kretsar

TSEK37

Valid from: 2017 Spring semester

**Determined by**

Board of Studies for Electrical  
Engineering, Physics and Mathematics

**Date determined**

2017-01-25

## Main field of study

Electrical Engineering

## Course level

Second cycle

## Advancement level

A1X

## Course offered for

- Electronics Engineering, Master's Programme
- Computer Science and Engineering, M Sc in Engineering
- Information Technology, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering

## Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites

Digital Integrated Circuits

## Intended learning outcomes

This course is intended to give knowledge and experience in design of analog integrated circuits for system-on-chip in nano-scale CMOS technologies. In addition, the course gives a detailed introduction to interconnect design as well as circuit techniques for on-chip timing, synchronization, and clock generation. After the course, students should have the following knowledge and skills:

- Understand CMOS circuit design challenges and possibilities.
- Be able to make small and large signal models for analysis of analog integrated circuits.
- Have indebt knowledge and skill in analysis, design, and evaluation of analog integrated circuits such as amplifiers and other versatile analog building blocks.
- Have skill and experience in using professional circuit simulators for design and evaluation of integrated circuits in presence of noise as well as process, voltage, and temperature variations.
- Understand on/off-chip interconnect modeling and design.
- Understand on-chip clock generation and clock synchronization methods and related circuits such as: oscillators, phase-locked-loops, and delay-locked-loops.

## Course content

The course will focus on the following topics:

- Small and large signal models for analysis of analog integrated circuits.
- Design, analysis, and evaluation of analog CMOS integrated circuits. As a representative benchmark, various types of amplifiers, current sources, voltage controlled oscillators, and other versatile circuit building blocks will be studied. The circuit analyses will take into account non-ideal effects such as noise and variations in process parameters, supply voltages, and operating temperature.
- Use of professional circuit simulators for design, analysis, and evaluation of integrated circuits.
- Modeling and design of interconnects. Particularly, studies on transmission lines for high-speed on-chip and off-chip communications.
- On-chip timing and synchronization techniques, including studies on clock- and data-recovery circuits and systems such as phase- and delay-locked-loops.

## Teaching and working methods

This course comprises lectures, tutorials, and laboratory exercises. The tutorials support the course by detailed analysis of some problem examples, and the laboratory exercises allows students to learn circuit design, simulations, and evaluation techniques utilizing professional CAD tools and standard CMOS process technology models and parameters.

## Examination

LAB1	Laboratory work	2 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

## Grades

Four-grade scale, LiU, U, 3, 4, 5

## Other information

Supplementary courses: VLSI Design Project

## Department

Institutionen för systemteknik

## Director of Studies or equivalent

Tomas Svensson

## Examiner

Atila Alvandpour

## Course website and other links

<http://www.isy.liu.se/en/edu/kurs/TSEK37/>

## Education components

Preliminary scheduled hours: 54 h

Recommended self-study hours: 106 h

## Course literature

### Additional literature

#### Books

Behzad Razavi, *Design of Analog CMOS Integrated Circuits 1*

ISBN: 0-07-238032-2

McGraw-Hill Higher Education

Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits 2*

ISBN: 0-13-120764-4

Prentice Hall (International edition)

## Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at [http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning\\_pa\\_grund-\\_och\\_avancerad\\_niva](http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).