



LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Integrerad radioelektronik **Integrated Radio Electronics**

ETIN30, 7,5 credits, A (Second Cycle)

Valid for: 2023/24

Faculty: Faculty of Engineering, LTH

Decided by: PLED E

Date of Decision: 2023-04-11

General Information

Elective for: E4-fh, E4-is, F4, MSOC1, N4

Language of instruction: The course will be given in English

Aim

The aim is to provide fundamental and broad knowledge about design and analysis of integrated high-frequency electronics. There is a high demand for such knowledge since more and more applications use wireless technology, e.g. mobile telephony, wireless computer networks, short range communications, and satellite navigation. In all these applications the radio transceiver is a very important component.

The emphasis of the course is methods for analysis and synthesis of integrated high-frequency electronics. It builds upon the Analogue IC Design (ETI063) and Radio (ETI031) courses, and the radio building blocks treated in the Radio course are here implemented primarily using CMOS technology. Methods for designing building blocks like amplifiers, mixers and oscillators are covered and applied in a project work where a complete receiver or transmitter is designed.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

- be able to describe different ways to realize radio building blocks such as low-noise amplifiers, mixers, oscillators, and power amplifiers on an integrated circuit, their detailed operation, and how important properties such as noise, linearity, gain and bandwidth depend on choice of component values and bias points.

- be able to describe how different components, especially inductors, can be realized on chip. The influence of parasitic capacitance and resistance at high frequencies, and how a layout should be planned as a consequence. How CAD-tools are used in RF IC design.
- be able to describe some system aspects for complete radio receivers and transmitters, and basic properties of different architectures.

Competences and skills

For a passing grade the student must

- be able to choose a suitable circuit topology for a given specification and to choose the parameters of the components involved such that the specification is met, and be able to analyze a given circuit regarding its function and performance. Be able to perform some calculations and make some choices on system level.
- be able to design layout for building blocks and components, especially inductors, and calculate their parasitics. Be able to use CAD-tools to simulate RF IC:s, draw their layout, and to verify the layout.

Judgement and approach

For a passing grade the student must

- have achieved sufficient basic knowledge and learnt the most common terms, so that he/she can discuss ideas, problems and solutions with people active in the RF IC design field.
- be able to judge if a design is suitable for integration on a CMOS chip or not.

Contents

The course is broad, covering topics from architecture level (homodyne, low-IF, heterodyne), via building block level (LNA:s, mixers, oscillators, power amplifiers), to component and layout level. When it comes to components, inductors and transformers can be realized on-chip, which is not possible at lower frequencies. The emphasis of the course is the building blocks and their realization in CMOS technology. Pros and cons of different circuits topologies are treated. It is an ambition to include also the latest circuit topologies from the research. Methods to choose component parameters to meet a certain specification, as well as methods to analyze given designs are central.

Modern CAD-tools for RF IC design is a key area in which the students will be introduced to and use in the course. In the project the participants will learn to simulate radio building blocks like amplifiers, mixers and oscillators using a modern circuit simulator especially developed for the purpose.

At the end of the course there is a guest lecture, where the lecturer tells about his work at an industrial RF IC design department.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Assessment: The project report must be approved.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Admission

Admission requirements:

- ETIN25 Analogue IC Design

The number of participants is limited to: No

The course overlaps following course/s: ETI170

Reading list

- Lee T H: The Design of CMOS Radio-Frequency Integrated Circuits, Second Edition. Cambridge University Press, 2004, ISBN: 0-521-83539-9.

Contact and other information

Course coordinator: Professor Henrik Sjöland, Henrik.Sjoland@eit.lth.se

Course homepage: <http://www.eit.lth.se/course/etin30>

Further information: An Introduction to Wireless Systems (EITF50) is recommended but is no prerequisite for ETIN30. With less than 16 participants, the course may be given with reduced teaching and more self studies.