Course syllabus

Höghastighetselektronik
High Speed Devices

EITP01, 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

Main field: Nanoscience.
Elective for: E4-fh, F4, F4-nf, F4-fel, MNAV2, MSOC1, N4-hn
Language of instruction: The course will be given in English on demand

Aim

This course aims at providing fundamental knowledge of the physics which enables the very high frequency operation of modern transistors. Basic amplifier design for microwave frequencies is introduced.

The course gives a modern description of transistors relevant for quantum well and FinFET devices, mainly based on ballistic transport.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- describe the physics behind the operation of ballistic field effect transistors
- explain the origin of the hybrid-pi model and transcapacitances.
- describe the fundamental high frequency parameters for basic amplifiers
- understand the Smith chart representation of transmission lines
- relate the high frequency performance of a device from the device geometry and materials properties

Competences and skills
For a passing grade the student must

- be able to perform relevant RF and DC calculations on transistors
- apply two-port description for transistor modeling
- calculate the maximum frequency performance of a transistor
- perform simple parameter extractions
- perform basic design of a microwave amplifier

Judgement and approach
For a passing grade the student must

- realize the need for device scaling for high performance transistors
- Understand the origins of the maximum frequency performance limits for transistors

Contents

Basic semiconductor physics: density of states, band structure and Fermi-Dirac statistics for two-dimensional quantum structures.

Ballistic and diffusive transport in semiconductors.

Small signal modeling and the two-port description. Current and power gains. Stability.

(Heterostructure) FET: Geometric layout. Diffusive and ballistic DC and AC models with transcapacitances. Parasitic resistances and capacitances. Noise properties

Transmission lines and Smith charts. Basic design of low noise amplifiers.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written exam, literature study presentation and approved hand-in and laboration.

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.

Parts
Code: 0119. **Name:** Written Examination.
Credits: 6. **Grading scale:** TH. **Assessment:** Passed exam
Code: 0219. **Name:** Hand In and Lab.
Credits: 0,5. **Grading scale:** UG. **Assessment:** Passed hand-in and laboration.
Code: 0319. **Name:** Litterature Study.
Credits: 1. **Grading scale:** UG. **Assessment:** Presented research article

Admission

Assumed prior knowledge: ESS030/ESSF20 or FFF021/FFN30 or ETIN70
The number of participants is limited to: No
The course overlaps following course/s: FFF115

Reading list

- Lecture Notes and Hand Outs.
- Mark Lundstrom, Jing Guo: Nanoscale Transistors, Device Physics, Modeling and Simulation. Springer, 2006, ISBN: 978-1-4419-3915-9. Avaliable online.

Contact and other information

Course coordinator: Erik Lind, erik.lind@eit.lth.se
Course homepage: http://www.eit.lth.se/course/eitp01