Electronic Circuits

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Lecturer

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  Office: Room 120, UM-SJTU JI Building
  Office hours: Monday and Thursday 13:15 - 14:15
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Schedule

- Lectures:
  - Monday 10:00 – 10:45 – Dong Zhong Yuan 2-103
  - Tuesday 14:00 – 15:40 – Dong Zhong Yuan 2-103
  - Thursday 10:00 – 11:40 – Dong Shang Yuan 206

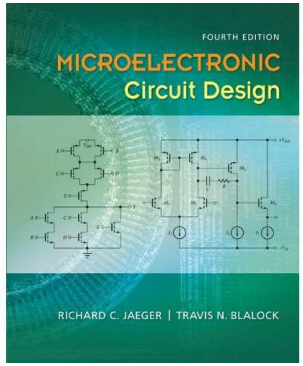
Electronic Circuits

- Introduction of nonlinear circuit elements
- Diodes and diode circuits
- Circuit models for bipolar junction and field-effect transistors
- Small-signal and piecewise analysis of nonlinear circuits
- Analysis and design of basic single-stage transistor amplifiers
- Biasing of single-stage transistor amplifiers
- Gain and frequency response of transistor amplifiers
- Digital logic circuits

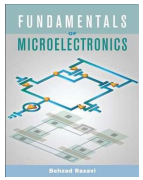
Books

Required text:

- Richard C. Jaeger and Travis N. Blalock, *Microelectronic Circuit Design*, 4th edition, McGraw Hill, 2011



Books



Recommended reference texts:

- Behzad Razavi, *Fundamentals of Microelectronics*, John Wiley & Sons, 2008
- Adel S. Sedra and Kenneth C. Smith, *Microelectronic Circuits*, Oxford University Press, 5th ed., 2003
- Paul R. Gray, Paul J. Hurst and Davis S. Lewis, and Robert Meyer, *Analysis and Design of Analog Integrated Circuits*, John Wiley & Sons, 5th ed., 2009

Other reference books:

Solid State Physics

- C. Kittel, *Introduction to Solid State Physics*, 7th ed., John Wiley & Sons, 1995
- J. S. Blakemore, *Solid State Physics*, Cambridege University Press, 1985
- Neil W. Ashcroft and N. David Mermin *Solid State Physics*, Brooks Cole, 1976
  - Classical texts on solid state physics.

Solid State Electronics

- A. S. Grove, *Physics and Technology of Semiconductor Devices*, John Wiley & Sons, 1967
- Ben G. Streetman og Sanjay Banerjee, *Solid State Electronic Devices*, 5th ed., Prentice Hall, 2000
- L. Solymar and D. Walsh, *Lectures on the Electrical Properties of Materials*, 5th ed., Oxford 1993
- Robert F. Pierret, *Semiconductor Device Fundamentals*, Addison-Wesley Pub Co 1996
- Y. P. Tsividis, *MOSFET Operation and Modeling of the MOS Transistor*, McGraw-Hill, 1988
- Gerold W. Neudeck, *The Bipolar Junction Transistor*, Addison-Wesley,1983

Integrated Circuit Fabrication

- R. C. Jaeger, *Introduction to microelectronic fabrication*, Addison-Wesley, 1993
- S. K. Ghandhi, *VLSI Fabrication Principles: Silicon and Gallium Arsenide*, 2nd ed., John Wiley & Sons, 1994
- S. M. Sze editor, *VLSI Technology 2nd ed.*, McGraw-Hill 1988
- C. Y. Chang and S. M. Sze editors, *ULSI Technology*, McGraw-Hill 1996
- James D. Plummer, Michael D. Deal, and Peter B. Griffin, *Silicon VLSI Technology: Fundamentals, Practice, and Modeling*, Prentice Hall, 2000
- Stephen A. Campbell, *The Science and Engineering of Microelectronic Fabrication* (Oxford Series in Electrical Engineering), Oxford University Press, 1996
- Michael Quirk and Julian Serda, *Semiconductor Manufacturing Technology*, Prentice Hall, 2000

VLSI Design

- W. Wolf, *Modern VLSI Design:Systems on Silicon*, Prentice Hall, 1998

Related Courses:

Ve215 Introduction to Circuits

- Kirchhoff's voltage and current laws
- Thévenin and Norton equivalent circuits
- Impedance

Ve320 Introduction to Semiconductor Devices

- pn junctions, metal-semiconductor junctions,
- bipolar junction transistors and MOSFETs

Related Courses:

Ve413 Monolithic Amplifier Circuits

- Analysis and design of BJT and MOS multi-transistor amplifiers
- Frequency response of amplifier circuits
  - Transfer function, bandwidth
- Feedback theory and application to feedback amplifiers
- Detailed analysis and design of BJT and MOS integrated operational amplifiers

Grading Policy

Grading

- Final Exam 40 % – Closed book
- Midterm Exam 1 15 % – Closed book
- Midterm Exam 2 15 % – Closed book
- Homework 20 %
- Laboratory 10 %

Homework

- Homework is assigned weekly (20 % of the final grade)

Lectures

- Most of the lectures will be given using viewgraphs
- Some of the lectures will be on the blackboard
- When viewgraphs are used the lectures are available at
  - `http://www.raunvis.hi.is/~tumi/Ve311.html`
- The homework assignments will be posted on the webpage
  - `http://www.raunvis.hi.is/~tumi/Ve311.html`
- Homework are due Tuesdays at 11:00 am

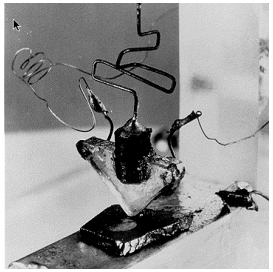
Laboratory

- The course includes five laboratory projects:
  1. Review of Passive Networks
  2. Characterization of the 741 Op Amp
  3. Configurable Amplifiers Using Small-Signal MOS Resistors
  4. Biasing of Bipolar Transistors
  5. Common-Emitter Single-Stage Amplifier Design Project
- All of those have a pre-lab and some include simulation using SPICE

The Honor Code

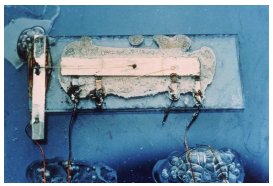
- You are expected to turn in your own work in all cases
- You are encouraged to discuss the homework assignments with your fellow students, but you have to come up with your own solution
- Many of the homework assignments and significant part of the laboratory work are design projects, that have infinite solutions, so there should be no 2 solutions alike.

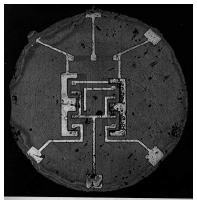
Introduction – The Transistor



- The first transistor was invented at Bell Laboratories on December 24, 1947 by William Shockley, John Bardeen (left) and Walter Brattain (right)
- They were awarded the Nobel Prize in physics in 1956

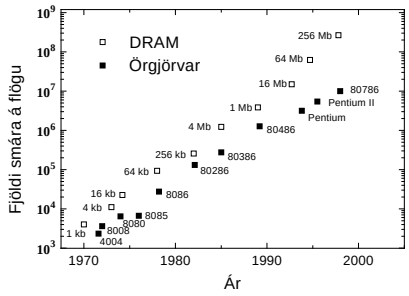
Introduction – The Integrated Circuit





- In 1958 Jack S. Kilby (Texas Instruments) demonstrated that it was possible to construct a simple integrated circuit in a semiconducting german
- In 1959 Robert Noyce (Fairchild Semiconductor) made an integrated circuit from silicon where SiO_2 was used as an insulator and Al as interconnects

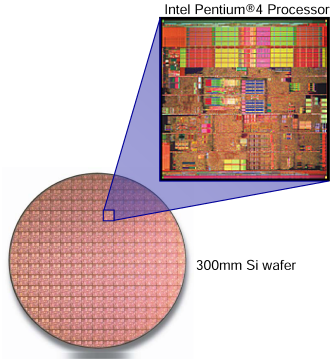
Introduction



- The number of devices on a die has doubled every 18 months, however the price of every die has remained unchanged - Moores law

Introduction

- By interconnecting a number of circuit elements, where each one can perform a simple task, it is possible to construct an integrated circuit that can perform a complicated job



Course Objectives

- To give a practical experience in analysis, measuremants and design of circuits that include nonlinear circuit elements
- To give a firm grounding in the analysis and design of MOS and bipolar analog single-stage amplifiers
- Circuit design is emphasized, in particular the use of SPICE as a simulation tool