The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6208 ADVANCED INTEGRATED ELECTRONICS

Credits: 15

Course Description including Aims

This course advances students' understanding of analogue and digital VLSI design, such that they can:

1. Understand the issues that define the limits of what is possible using VLSI.
2. Understand techniques that will allow circuits to be analysed from a variety of perspectives.
3. Design multistage VLSI signal amplifiers & model their performance using SPICE
4. Design D to A and A to D converters.

Outline Syllabus

Test: Testing aims. Test techniques: Design for testability; structured approaches; scan path; signature analysis and BIST. **Interconnect:** trends and problems. **Power consumption**: dynamic and static power; trends. **Non-CMOS Logic:** Dynamic logic,Ratioed logic. **Circuit Layout:** standard CMOS processing. **Amplifiers:** review of single stage and multi-stage amplifier design. Feedback, frequency response and noise characterization of amplifiers. **SPICE:** using high level MOSFET models. **Converters:** principles of DAC and ADC operation.

Time Allocation

36 lectures plus 12 hours of additional support material.

Recommended Previous Courses

EEE335 or EEE348.

Assessment

2 Hour Examination 3/4 questions (75%) + 2 mid-semester assignments/class tests (25%)

Recommended Books

Weste N & Eshragian K	*Principles of CMOS VLSI Design A Systems Perspective*	Addison Wesley
	Technology Roadmap for Semiconductors 2014	http://www.itrs2.net
Kang S & Leblebici Y	*CMOS Digital Integrated Circuits 4/Ed*	McGraw Hill
Uyemura J P	*Introduction to VLSI Circuits and Systems*	Wiley
Smith M J S	*Application-Specific Integrated Circuits*	Addison Wesley
Rabaey J	*Digital Integrated Circuits - A Design Perspective*	Prentice Hall
Geiger R L, Allen P E & Strader N R	*VLSI Design Techniques for Analog and Digital Circuits.*	McGraw Hill
Carusone, T, Johns, D and Martin, K	*Analog integrated circuit design*	Wiley

Objectives

By the end of this unit successful students will be able to:

1. Understand the importance of interconnect as a limit to performance and the effect that it has on power consumption;
2. Calculate the power consumption of circuits and be able to estimate the performance of larger systems;
3. Understand the importance of testing and testability and be able to devise testing strategies for circuits;
4. Design dynamic and pass-transistor logic gates based on an understanding of the required logic and the behaviour of the technology. Students should also be able to estimate the performance of these gates (power, speed, area).
5. Design a CMOS folded-cascode op-amp and use realistic SPICE MOSFET models to assess its performance.
6. Analyse the operating point, small signal performance and frequency response and assess the stability of a range of amplifier designs.
7. Use feedback to stabilise amplifier circuits.
8. Describe the effects of noise on different amplifier designs
9. Describe the operation of DAC and ADC converters

Detailed Syllabus

1. VLSI processing technology
2. CMOS layout, design rules, scaling
3. MOSFET operation
4. Static CMOS review5. Interconnect: trends, performance, buffering, and hierarchy
6. Clock distribution, power distribution, and I/O7. Circuit delays and timing analysis8. Power consumption
9. Non-CMOS Logic –Ratioed Logic
10. Non-CMOS Logic –Dynamic Logic
11. Test and testability – structured approaches to test
12. SPICE
13. Review of MOSFET operation
14. Single stage amplifier design
15. Two stage amplifier design
16. Folded cascode common-source amplifier
17. Folded cascode differential pair
18. Amplifier frequency response (Miller's theorem, open-circuit time constants).
19. Amplifier frequency response (performance of the differential pair at high frequencies).
20. Principles of feedback, amplifier stability
21. Stable amplifier design using negative feedback
22. Noise in IC amplifiers
23. Principles of DAC and ADC operation.

UK-SPEC - IET Learning Outcomes

Outcome Code	Supporting Statement
SM1m / SM1fl	Elements of circuit theory,semiconductor device behaviour, and device fabrication are considered. This is assessed by examination.
SM2p	Various algebraic manipulations and differential calculus employed along with aspects of Boolean algebra. This will be assessed, where appropriate, within relevant questions.
SM2m	The course considers VLSI across a range of levels from system down to device and naturally draws from semiconductors, circuit theory and (to a smaller extent) system design. This extends to modelling of circuits and devices. Aspects of this knowledge and understanding will be assessed in the examination.
EA1m / EA1fl	Part of the course looks at the analysis of non-CMOS digital building blocks, allowing the students to undertake first order analyses of behaviour and performance. The ability to understand and apply these principles is assessed in the examination.
EA2m	Mathematical modelling is used to describe the behaviour of logic circuits e.g. speed, area, power consumption, cost. This ability to characterise performance is assessed in the examination. Students will use small signal analysis together with SPICE simulations to model and assess the performance of a range of IC amplifier designs.
EA2fl	Students are provided with sufficient grounding to allow application of the principles covered to new and unfamiliar cases. Emerging technologies are examined.
EA3p / EA3m	Circuit Simulation tools are used to allow complex circuits to be analysed. This will form part of a non-examined assessment.
EA5m	Students are provided with sufficient grounding to allow application of the principles covered to new and unfamiliar cases. Emerging technologies are examined.
D7m	Design methodologies, design flows, and processes and how these impact on design. Students are expected to be able to describe the need for and applicability of methodologies.
D2fl	Design methodologies, design flows, and processes and how these impact on design. Students are expected to be able to describe the need for and applicability of methodologies.
EP1fl	Students will understand the basics of IC fabrication and associated costs, issues, trends, and limitations.
EP2m / EP2fl	Students will understand the basics of IC fabrication and associated costs, issues, trends, and limitations.
EP9m	Students are made aware of the pivotal role of the roadmap in predicting future capability, Additionally, students will know what the future challenges and likely limits of VLSI are.
EP4p / EP4m	Students will be made aware of relevant papers and the SIA roadmap