EL421 Introduction to VLSI Circuits

Credit Structure (L-T-P-Cr): 3-0-2-4  
Semester: Autumn 2018

Course Objectives:

- To give the basics and fundamentals of VLSI circuits and system design, defining trends in VLSI industry and making students aware of future state-of-the-art developing technologies.
- To impart knowledge about MOS models and their characterization.
- To define the basic fabrication steps of MOS transistor and layout designing of VLSI circuits.
- Designing of static and dynamic circuits using MOSFETs. Computation and analysis of output performance parameters.
- To study different on-chip interconnect structures, modeling schemes, non-ideal effects, remedial measures and advanced interconnect materials and techniques.

Course Contents:

1. Introduction

Review and characterization of semiconductor materials and devices, Vacuum Tube technology, BJT, emergence of VLSI technology, benefits and challenges of VLSI technology, Moore’s Law, ITRS report sheets and trend understanding.

2. Basics of MOSFETs

Basic principle of MOSFETs, DC, small signal, high frequency and noise models of MOSFETs, MOS capacitors. MOS models: Level-1 and Level-2 large signal MOSFET models. Introduction to BSIM models. Extraction of MOSFET model parameters. IV characteristics.

3. CMOS Fabrication Technology

Process steps for extraction of silicon and development of ingot, Wafer preparation, Fabrication of integrated circuits.

4. Device Scaling

Scaling fundamentals, types of scaling, short and narrow channel MOSFETs.
5. MOS Inverters
Static and Dynamic characteristics: Inverter principle, Depletion and enhancement load inverters, the basic CMOS inverter, transfer characteristics, logic threshold, noise margins, dynamic behavior, transition time, propagation delay, power consumption.

6. MOS Circuit Layout and Simulation
Layout design rules, MOS device layout: Transistor layout, Inverter layout, CMOS digital circuits layout and simulation, circuit extraction and post-layout simulation.

7. Combinational MOS Logic Designs
Static MOS design, Complementary MOS, Ratioed logic, Pass transistor logic, complex logic circuits, transmission gate logic designs.

8. Dynamic and Sequential MOS Designs
Dynamic logic families and their performance analysis. Static latches, Flip flops and Registers. CMOS Schmitt trigger, Monostable sequential circuits, Astable circuits, CMOS current mirror designs, CMOS amplifiers, Comparator designs, Adder and Multiplier circuits.

9. Memory Design
ROM and RAM cells design.

10. VLSI Interconnects

11. BiCMOS Logic
Introduction to BiCMOS, BiCMOS based circuit designs.

Text Books:

Reference Books:

1. H.M. Rashid, Introduction to PSPICE, PHI.
2. B.G. Streetman & S. Banerjee, Solid State Electronic Devices, PHI.
5. Eshraghian and Pucknell, Introduction to VLSI, PHI.

Course Evaluation Policy:

I  In-Semester Examination:                    15%
II In-Semester Examination:                    15%
End-Semester Examination:                     25%
Labs:                                                         25%
Project*:                                                   10%
Others (Quiz, Attendance):                      10%
Total:                                              100%

* Project shall comprise of a few assignments, circuit design and implementation using Cadence and/or paper presentation/writing.