

ESE 330

Integrated Electronics

Fall 2017

Stony Brook University
Department of Electrical and Computer Engineering

Course Description

This course presents a study of the analysis and design of digital integrated circuits. Topics include fabrication and modeling of MOS transistors; the transistor-level design of combinational and sequential digital logic; mask layout methods, design rules and processes; circuit characterization and performance estimation; computer-aided design tools and techniques. This material is directly applicable to industrial IC design and provides a strong background for more advanced courses.

Prerequisites : ESE 372

Instructor : Milutin Stanacevic
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Classes : MWF 12:00pm-12:53pm, in Frey Hall 201

Office hours : MW 10:00am-12:00pm, or by appointment

Teaching Assistant : Wenbin Hou (wenbin.hou@stonybrook.edu)

Textbooks :

J. M. Rabaey, A. Chandrakasan and B. Nikolic, “*Digital Integrated Circuits: A Design Perspective*,” Prentice Hall, 2nd edition, 2003.

Grading

1. Homework 10%
2. Midterm 35%
3. Final 35%
4. Project 20%

Project

There will be three design projects in the class(20% of grade). The goal of the projects is the design and implementation of a modest-size CMOS digital integrated circuit. Cadence will be used as the industry-standard VLSI design and analysis tool.

Course Outline

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| Week 1 | Introduction (ch 1.1 - 1.3) |
| Week 2 | The Diode (ch 3.2) and MOS transistor (operation) (ch 3.3.1-3.3.2) |
| Week 3 | The MOS transistor (the long- and short-channel model) (ch 3.3.3-3.3.4) |
| Week 4 | IC manufacturing; design rules (ch 2.1 - 2.3) |
| Week 5 | The CMOS inverter (static characteristics) (ch 5.1 - 5.3) |
| Week 6 | The CMOS inverter (propagation delay) (ch 5.4) |
| Week 7 | The chain of inverters. Power consumption (ch 5.5). |
| Week 8 | Static CMOS logic (complex gates and propagation delay) (ch 6.1 - 6.2) |
| Week 9 | Static CMOS logic (optimal sizing). Dynamic CMOS logic (ch 6.3 - 6.4) |
| Week 10 | Dynamic CMOS logic (domino logic) |
| Week 11 | Sequential static logic (ch 7.1 - 7.3) |
| Week 12 | Sequential dynamic logic (ch 7.5 - 7.6) |
| Week 13 | The wire (ch 4.1 - 4.4) |
| Week 14 | Semiconductor memories (ch 12.1 - 12.2) |

Goals:

The course is designed to provide students with in-depth analysis and design capability required for digital integrated circuits.

Objectives:

Understand the I-V characteristics of deep-submicron MOS transistors.

Understand the limited validity of simple I-V MOS models and be able to extract model parameters.

Calculate the device parasitic capacitances.

Calculate the logic high/low input/output voltages of a specified NMOS and CMOS inverter and draw the transfer curve and calculate the noise margins of a specified CMOS inverter.

Design simple NMOS and CMOS logic gates for speed, area or power.

Analyze and design static and dynamic latches and flip-flops.

Be proficient at using a circuit simulator to study the circuit response.

Understand the sources of power dissipation.

Apply approximate methods to calculate the delays of inverters.

Understand and apply transistor sizing techniques for minimizing delay through a single combinational logic gate or a chain of logic gates.

Analyze and design dynamic logic gates.

Understand the architecture of ROM and RAM circuits.

Analyze and design a memory array decoder.

Analyze and design an SRAM memory cell.

Understand and apply the Elmore delay formula for RC delay calculations.

Access to our class's on-line Blackboard site:

You can access class information on-line at: <http://blackboard.sunysb.edu>

If you have used Stony Brook's Blackboard system previously, your login information (Username and Password) has not changed. If you have never used Stony Brook's Blackboard system, your initial password is your SOLAR ID# and your username is the same as your Stony Brook (sparky) username, which is generally your first initial and the first 7 letters of your last name.

For help or more information see:

<http://www.sinc.sunysb.edu/helpdesk/docs/blackboard/bbstudent.php>

For problems logging in, go to the helpdesk in the Main Library SINC Site or the Union SINC Site, you can also call: 631-632-9602 or e-mail: helpme@ic.sunysb.edu

Electronic Communication Statement:

Email and especially email sent via Blackboard (<http://blackboard.stonybrook.edu>) is one of the ways the faculty officially communicates with you for this course. It is your responsibility to make sure that you read your email in your official University email account. For most students that is Google Apps for Education (<http://www.stonybrook.edu/mycloud>), but you may verify your official Electronic Post Office (EPO) address at <http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo>.

If you choose to forward your official University email to another off-campus account, faculty are not responsible for any undeliverable messages to your alternative personal accounts. You can set up Google Mail forwarding using these DoIT-provided instructions found at <http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail>.

If you need technical assistance, please contact Client Support at [\(631\) 632-9800](tel:631-632-9800) or supportteam@stonybrook.edu.

Americans with Disabilities Act:

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

Academic Integrity:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-

specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at <http://www.stonybrook.edu/uaa/academicjudiciary/>

Critical Incident Management:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.