### VLSI Workshop Day 2

**Today’s Topic:** Revised Course Content

<table>
<thead>
<tr>
<th>Time</th>
<th>DAY 1</th>
<th>DAY 2</th>
<th>DAY 3</th>
<th>DAY 4</th>
<th>DAY 5</th>
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</thead>
<tbody>
<tr>
<td>9:00</td>
<td>common session</td>
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<tr>
<td>9:30</td>
<td>Introduction: VLSI Curriculum; Course Content Overview</td>
<td>Course content: technology &amp; device models</td>
<td>Teaching skills; effective lectures</td>
<td>DIS: Research in Education</td>
<td>DIS: Engaging in Research</td>
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<td>10:00</td>
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<td></td>
<td>New tech. resources</td>
<td>Research: MEMS &amp; Sensors</td>
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<td>10:30</td>
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<td>Trends in VLSI</td>
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<tr>
<td>11:00</td>
<td>Components of VLSI Course</td>
<td>Course content: CMOS logic, layout, sequential logic</td>
<td>Teaching resources; effective homework, exams, labs</td>
<td>Trends in VLSI</td>
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<td>11:30</td>
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<td>VLSI Implementations of DSP</td>
<td>Research: Bio-medical Electronics</td>
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<td>12:30</td>
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<td>2:00</td>
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<tr>
<td>2:30</td>
<td>Components of VLSI Course</td>
<td>Advanced/grad topics &amp; courses</td>
<td>BOG: Session A</td>
<td>BOG: VLSI Course Content Lectures</td>
<td>BOG: New Technology Lectures</td>
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<td>3:30</td>
<td>DIS: What BOGs do you want?</td>
<td>DIS: Challenges to Teaching VLSI</td>
<td>BOG: Session B</td>
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<td>4:00</td>
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<td>DIS: BOG</td>
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<td>4:30</td>
<td>DIS: Break Out Groups &amp; Lectures</td>
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<td>DIS: Summary &amp; Action Items</td>
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<td>5:00</td>
<td>Questionnaire</td>
<td>Course Lecture</td>
<td>Course Lecture</td>
<td>New Tech Lecture</td>
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Day 2 Agenda

Morning
• Collect Questionnaires
• Questions from Day 1?
• Review content of my VLSI Design course
• Present lecture on material of your choice

Afternoon
• Discuss advanced & graduate course topics
• Discuss challenges & solutions to teaching VLSI
• Review upcoming Break Out Groups (BOGs)
• Choose lecture topics
Course Topics I

• CMOS Logic
  • MOSFET switch, Boolean logic in CMOS

• CMOS Technology
  • layers, process flow, parasitics, fabrication techniques
  • critical to understanding performance issues

• CMOS Layout
  • design rules, layout principles, stick diagram, cell hierarchy
  • essential for analog/mixed-signal and microsystems

• MOSFET Physics & Models
  • semiconductor physics, diode & MOSFET models, CMOS capacitances
  • content varies based on student background

• Digital Gate Analysis
  • transient & DC timing analysis of INV
  • transient & DC analysis of NAND/NOR & beyond
  • static and dynamic power analysis
  • design for performance: transistor sizing
  • critical for cell library design & performance optimization

All notes (PPT slides) for my lectures are on the web at www.egr.msu.edu/classes/ece410/mason/
Course Topics II

• Cell Layout & Chip Floorplanning
  • standard cell layout structure, multi-cell layout, power & signal routing,
    use of metal layers, floorplanning

• Structure & Operation of Digital Functions
  • Basic Gates (MUX, En/Decoder, FF, Shifters, Registers, etc.)
  • Arithmetic Circuits, mainly adders (Manchester in CMOS)
  • Memory (SRAM, DRAM, ROMs, PROMs, PLA, FPGA)

• Design Project
  • Microprocessor datapath with ALU, SRAM, and shifter

• Advanced Logic Structures
  • dynamic, differential, pass-gate

• Submicron Issues
  • MOSFET submicron models, design considerations/limits, submicron
    technology (physical structures)

What topics would you like to review?
Advanced & Graduate Course Topics

• Outline
  • Advanced topics in undergrad VLSI course
  • Beyond VLSI Design: related undergrad and grad courses
  • Open Discussion
    • How can you add interest to your course with advanced topics
    • How can you expand/improve your curriculum beyond VLSI Design
Advanced Course Topics

• Why advanced topics in undergrad VLSI course?
  • gives student some idea what is beyond current course
    • helpful in choosing other course or career path
  • gives students some insight on start-of-the-art issues
  • gives instructor a chance to study & present something new

• Choosing advanced topics
  • relevant to student interests or career options
  • interesting to instructor
  • up-to-date

• Idea for interactive learning
  • assign students to individually study an advanced topic
    (maybe pick from a list you provide) and present it in your class
    • they develop professional skills & you learn something new
Possible Advanced Course Topics

• VLSI technology issues
  • submicron fabrication
  • MEMS
• Next-generation alternatives to CMOS
  • BiCMOS or compound semiconductors
  • quantum or bimolecular devices
• Advanced Digital Systems
  • wireless digital radio
• Analog/mixed-signal design
• Preview of other senior(final)-level courses
  • computer architecture
  • HDL/FPGA design
  • embedded systems
Beyond VLSI Design

Where do students that love your VLSI Design course go next?

• System on Chip Design
• IC Testing (lab-based)
• Instrumentation
• Advanced VLSI Design
  • advanced gate structures, submicron design, low voltage/power design
  • floorplanning, I/O structures, I/O protocols, BIST, testability
• VLSI Implementation of Signal Processing Algorithms
• Others?
  •
  •
  •
  •
Open Discussion: Challenges to Teaching VLSI Design

Agenda

• Metrics to assess effectiveness
  • How do you determine a challenge exists?

• Identify challenges and discuss solutions
  • Organize by categories
    • Administrative/Curriculum
    • Effective Teaching
    • Students
    • Resources

NOTE: For workshop participants, notes for this session are in Day 1, slide 25+.
Metrics for Challenge Assessment

How do you recognize there is a challenge to overcome? What metrics can assess effectiveness of our course?

• Student interest
• Student understanding
• Student placement
• Reputation to employers
• Difficulty (time, stress, etc.) of teaching
• Others?
  •
  •
  •
Challenges: Administrative/Curriculum

• Student’s don’t have adequate background
  • adjust content of preceding courses
  • cover background in your course
• I don’t have enough time to prepare effective lectures/homework/labs
  • work with administrators
  • cut back & focus on key concepts

•
Challenges: Effective Teaching

• I can not keep my students interested
  • interactive teaching; challenge with questions (more in day 3)
  • real-life practical examples/analogies
  • guest speakers from industry; show importance of class

• Homework not effective or appropriately challenging
  • study homework from other instructors or other textbooks
  • break problems into steps; easier for students and grading

• I repeat answers to same questions in office hours
  • consider ‘group office hours’ or discussion sessions
Challenges: Students

- Students more interested in IT than VLSI
  - make VLSI exciting
  - develop understanding of role of VLSI material for future industry
  -
- Students fail to understand key concepts
  - spend more time teaching those concepts
  - seek new/different examples, illustrations, etc.
  - develop step-by-step homework on difficult concepts
- Students do not study/practice outside of class
  - random quick (5 min) quizzes
  - bonus points for attending office hours
  - increase importance of homework to overall grade
- Students do not have enough time to learn complex material or do complex lab assignments
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Challenges: Resources

To run efficiently, a VLSI course needs good CAD tools, staff support for CAD tools, a TA for help with lab assignments, and well-planned labs.

- My school does not have adequate VLSI CAD tools
  - use free SPICE and stick diagrams
  - use cheaper tools (Tanner vs. Cadence)
  - supplement CMOS science & technology with HDL design & simulation

- I have to grade my own homework and don’t have time
  - supplement calculation problems with T/F or multiple choice problems
    - the key is to get students studying daily/weekly
  - grade only on effort; provide solutions & have students check their own work
Session 5

DIS: Upcoming Break Out Groups

• Day 3
  • Session A (pick one)
    • Preparing homework
    • Developing final year projects
    • Establishing relations with industry
    • Getting chips fabricated/tested
  • Session B (pick one)
    • Setting up VLSI lab assignments
    • Developing PG projects
    • Engaging in research
    • Evolving/expanding curriculum
• Day 4
  • Practice lectures
• Day 5
  • Present ‘new technology’
Assignment: Lecture Topics

• On Day 4, each of you will give a brief (~10min) lecture of VLSI Design material to your break-out group.
  • Lectures should incorporate “effective teaching” practices (discussed tomorrow/Day 3)
  • Lectures will be discussed by working group to identify strengths and weaknesses in your presentation
  • Use of whiteboard, PPT slides, etc. is up to each individual
  • Welcome to use notes from my VLSI Design course
• Topics chosen from list to follow, or pick your own
  • must be specific topic suitable for ~10 min presentation
• Group will provide ~5 min evaluation
  • positive and critical feedback to help you improve
• Form break-out groups now and choose topics
  • one presenter for each topic within a group, please
• Questions?
Possible Lecture Topics

- Implementing a generic logic function in CMOS
- Physical layers in CMOS process
- Specific fabrication technique (e.g., thermal oxidation)
- Layout design rules
- Stick diagrams
- INV DC analysis (gate switching threshold)
- INV Transient analysis (rise/fall times)
- Power consumption in CMOS
- MOSFET I-V Characteristics or RC Model
- Origin of parasitic capacitances in CMOS
- Concept of hierarchical design
- Routing/interconnectivity rules in CMOS layout
- CMOS structure for specific digital gate (e.g., flip flop, decoder)
- CMOS structure for specific arithmetic gate
- CMOS structure for specific type of memory
- A specific advanced logic structure (e.g., dynamic/domino)

Start preparing your lecture tonight!