VLSI Workshop Day 2

- Today's Topic: **Revised** Course Content

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

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?
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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?
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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
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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
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Challenges: Students

- Students more interested in IT than VLSI
  - make VLSI exciting
  - develop understanding of role of VLSI material for future industry
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- 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 wit 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
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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!