ELEN6321 (W2013): Advanced Digital Electronics Design, Course Syllabus

In this course, we will study advanced and "hot" topics in modern VLSI integrated circuits (IC) design. Along with 2 lectures per week, this course has a large emphasis on the team projects where 4-6 students are expected to work together from topic selections to chip-level integrations. Compared to ELEN4321, this is a true graduate course, which means you are expected to study as student scholars. You will have more freedom to be creative, and your project will be evaluated against "state-of-the-arts". In this sense, this class will be very demanding but also rewarding. You will have a chance to learn the end-to-end flow of modern CMOS IC design. The topics that will be covered in both lecture and projects include:

- Modern and emerging integrated circuit technology
- Static and dynamic logic families
- Noise sources, analysis and avoidance
- Process variations and design for manufacturing (DFM)
- Low power and ultra low power design
- Leakage characteristics and low leakage design
- Adaptive design over PVT variations
- Packaging and on-chip power supply design
- Interconnect and signaling
- Clock design
- Synchronization issues
- Embedded SRAM and DRAM
- Design for reliability

Instructor: Prof. Mingoo Seok (mgseok@ee.columbia.edu)
Teaching Assistant: Josh kim (sk3667@columbia.edu)
Grading: The course has mid and final exams which constitute 25+25% of the final grade. A final group project will be worth 40% (10% for design review 1, 10% for design review 2, and 20% for final presentations). Lecture/lab participations will take the remaining 10%. Total credit: 4.5 pts
Time/Location:

- Lectures (led by the instructor): 10:10-11:25am on MW, 227 MUDD
- Lab discussions (led by the TA): TBN, TBN
- Office HRs: Monday 11:30-12:30pm for Prof. Mingoo Seok

Prerequisites: ELEN4312. Students are expected to be familiar with basic digital and analog circuit design, device physics, logic design, and computer architecture. Students should have completed a medium scale CMOS IC design project, including schematic designs, timing/power simulations, physical designs, and system integrations. Background in computer design (EECS E4340), analog circuit design, and device physics (ELEN6302 or its prerequisites) will be useful. A reference course flowchart is located at http://www.ee.columbia.edu/pdf-files/CourseFlowchartG2.pdf

Text Books: We are primarily using slides but here are several references you may want to use. Most of them are reserved in the library

- A. Chandrakasan, et al., *Design of High-Performance Microprocessor Circuits,* IEEE Press, 2001
- D. Harris, *Skew-tolerant Circuit Design*, Morgan Kaufmann, 2000.
- K. Bernstein, et al., *High Speed CMOS Design Styles*, Kluwer Academic Publishers , 1998.
- N. Weste and D. Harris, *CMOS VLSI Design*, Addison-Wesley, 4th edition, 2010.

Course Websites:

- We will use the CourseWorks (https://courseworks.columbia.edu/) for materials, announcements, and discussions for both lectures and labs.