ECE 3221: Digital Integrated Circuits

Credits and contact hours: 3 Credits (Two 75-minute lectures per week)

Instructor: Lei Wang

Textbook: Digital Integrated Circuits: Analysis and Design, 2nd Edition, J. E. Ayers (2009).

Other supplemental material: Class Notes – Topics not covered in the text (e.g., technology scaling)

***Specific course information*:**

a. *Catalog Description*: Switching, timing, wave shaping, and logic circuits to generate waveforms and functions used in pulse systems, instrumentation and computers. Emphasis is on integrated circuits.

b. *Prerequisite*: ECE 3201 and CSE 2300W.

c. *Required, elective, or selected elective:* Selected elective (EE)

***Specific goals for the course*:**

a. *Specific outcomes of instruction*: Students will be able to
   - Describe the physical operation of metal oxide semiconductor field effect transistors (MOSFETs), including short-channel effects in submicron devices
   - Analyze different MOS active load inverters incorporating change in threshold voltage of load transistors.
   - Use iterative techniques to calculate VTCs using hand calculation and SPICE simulation in the CADENCE environment.
   - Use capacitance modeling to calculate switching speeds.

b. *EAC Criterion 3 Student Outcomes addressed by the course*:

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
Students apply knowledge of algebra, calculus, electronic device physics, and circuit theory to analyze MOSFET digital logic circuits.

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
Students are required to design transistors and logic gates circuits to meet given specifications, such as switching speed, fan-out, power dissipation, or noise margins.

(3) an ability to communicate effectively with a range of audiences
n/a

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

Students are introduced to the International Technology Roadmap for Semiconductors (ITRS). Numerous examples are used in class to illustrate the current state-of-the-art in fabrication and design or devices and circuits.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

n/a

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

n/a

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

n/a

Topics covered:

- Basic properties of digital integrated circuits
- Semiconductors and p-n, pnp, and npn junctions
- Metal oxide semiconductor field effect transistors (MOSFETs)
- MOS logic gates, static properties, dynamic performance, and design
- CMOS logic gates, static properties, dynamic performance, and design
- Dynamic CMOS circuits