# ELEC 5801 / ELG 6373
# High-Speed and Low-Power VLSI Circuits and Systems

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**Course Description**

Speed and power consumption are the most important aspects of VLSI circuits and systems. The IC revolution is indebted to the development of denser and faster chips. The convenience of portability would have been impossible without low-power electronics. This course addresses the application of high-speed and low-power circuit techniques at different levels of abstraction, including transistors, circuits, logic-gates, modules, and system levels. It covers the state-of-the-art techniques to estimate and optimize the performance and energy consumption (static and dynamic) of digital circuits. These techniques and concepts are practiced through assignments and projects.

**Marking Scheme**

- Assignments 45%
- Project 30%
- Final Exam 25%

**Course Objectives**

- Reviewing the structure, operation, and behaviour of MOSFETs
- Reviewing CMOS logic gates and layout
- Understanding DC and transient response of logic gates
- Studying the concept of logic gates design and analysis based on equivalent inverters
- Applying the method of logical effort to optimize circuit delays
- Understanding sources of static and dynamic power dissipations
- Studying methods of managing static and dynamic power dissipations
- Studying various CMOS logic families

**Course Content**

1. Introduction to Digital Circuits and Systems
2. MOSFET Theory and Operation
3. CMOS Logic Gates and Layout
4. Brief CMOS Fabrication Process
5. Non-ideal MOSFET Behaviour
6. DC and Transient Response of Logic Gates
7. Reliability and Noise Margins

8. Equivalent Inverter Method for Analysis and Design of Logic Gates
9. Method of Logical Effort for Delay Optimization
10. Asymmetric and Skewed Logic Gates
11. Power and Energy Consumption
12. Dynamic Power Estimation and Management
13. Static Power Sources and Reduction
14. Static CMOS Logic Styles
15. Dynamic CMOS Logic Gates
16. Sequential Logic Circuits
17. Logic Modules
18. Fundamentals of Memories
19. Testing of Digital Circuits
20. FinFETs

**Textbook**

- N. Weste and D. Harris, "*CMOS VLSI Design: A Circuits and Systems Perspective,*" 4th Edition, Addison Wesley, 2011.

**References**


- J. Rabaey, A. Chandrakasan, and B. Nikolic, "*Digital Integrated Circuits: A Design Perspective*," 2nd Edition, Prentice Hall, 2003.
- M. Pedram and J. M. Rabaey, *Power Aware Design Methodologies*, Boston: Springer, 2002.
- V. G. Oklobdzija, V. M. Stojanovic, D. M. Markovic and N. Nedovic, *Digital System Clocking: High Performance and Low-Power Aspects*, Wiley-IEEE, 2005.
- Chandrakasan and R. Brodersen, *Low-Power CMOS Design*, New York: IEEE Press, 1998.
- K.-S. Yeo and K. Roy, *Low-Voltage Low-Power Subsystems*, McGraw Hill, 2004.