# EEC 289O - Low Power Digital Integrated Circuit Design

**Lecture:** MWF 9-10
XXX Any Hall

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**Prerequisites:** 116 or 118 or 218A, or by consent of instructor.

**Grading:** Letter
Homework 25%
Midterm 15%
Design Project 1 15%
Design Project 2 20%
Final 25%

**Course Description:** IC design for low power and energy consumption. Low power architectures, logic styles, and circuit design. Variable supply and threshold voltages. Leakage management. Power estimation. Energy sources, power electronics, and energy recovery. Applications in portable electronics and sensors. Thermodynamic limits.

**Course Outline:**

I. Overview of Low Power Design

   A. CMOS Power Dissipation

   B. Power and Performance Tradeoffs

   C. Trends in IC Power Consumption

II. Low Power Architectures

   A. Clock Gating and Clock Management

   B. Pipelining to Reduce Supply Voltage

   C. Parallelization to Reduce Supply Voltage

III. Low Power Circuit Design

   A. Logic Power Estimation

B. Power Minimization in Static CMOS
C. Power Minimization in Dynamic CMOS
D. Multiple-Threshold CMOS
E. Variable Supply and Threshold Voltages
F. Managing Leakage
G. Silicon-on-Insulator (SOI) Technologies
H. Energy Recovery
I. Interconnect Power Estimation and Management

IV. Energy Sources and Power Electronics

A. Batteries and Fuel Cells
B. Energy Scavenging
C. DC/DC Converters: Fundamentals
D. DC/DC Converters: Optimization

V. Other Topics in Low Power Design

A. Low Power Synthesis
B. Applications: Computing, Communication, and Multimedia
C. Applications: Sensors and Sensor Networks
D. Fundamental Limits and Thermodynamics of Computation

**Reading:**

1. Most material will be from classic and recent research papers on low power design.

**Reference Material:**


1. Roy, K. and Prasad, S., *Low Power CMOS VLSI: Circuit Design.*
2. Chandrakasan, A. and Broderson, R., eds., *Low-Power CMOS Design.*
3. Chandrakasan, A. and Broderson, R., *Low Power Digital CMOS Design.*
4. Rabaey, J., Chandrakasan, A., and Nikolic, B., *Digital Integrated Circuits: A Design Perspective*, 2nd ed.
5. Kassakian, J., Schlecht, M., and Verghese, G., *Principles of Power Electronics.*