Electrical and Computer Engineering, Rutgers University
Spring 2024
Integrated Transistor Circuit Design

Course number: 16:332:588:01

Time: Mondays and Thursdays, 10:20 AM – 11:40 AM in HLL - 009

Instructor information:
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Course overview/description

This course introduces the fundamentals and operating principles of three-dimensional transistor (*e.g.* FinFET) and explores advanced IC design with 3D Transistor and aim to understand the superior performances over conventional 2D MOSFET transistors. Highly advanced Nanofabrication/manufacturing processes for ultra-thin 2D and 3D transistors are presented to comprehensively elucidate 3D transistors. Design criteria followed by the effects of short-channel and quantum-mechanical phenomenon for 3D transistors is also addressed. In addition, Photonic circuits enable ultra-fast, highly energy efficient devices, by utilizing photons from the merging together with modernized electronics. In this course, the fundamentals of photonic circuits and components are concisely introduced, emerging as technological revolution of micro/nano-electronics. Practical photonic circuit design with the 3D FDTD simulation tool as a basic level will be provided.

Topics covered

- Overview of Field Effect Transistors in Modern Electronics
- Nanoscale 2D/ 3D Transistor Fabrication/Manufacturing processes
- Ultra-Thin Body (UTB) MOSFETs
  ; Long-channel/Short-channel effects and Quantum-mechanical effects on threshold voltage
  ; Gate-Source/Drain underlap; effective channel length, doping profile for source and drain
- SOI MOSFET
- Low Voltage Analog Integrated Circuit Design*
- 3D Transistors: FinFET, multi-gate Transistor
  ; Effects of Doping and Gate width in FINFET
  ; Fringe capacitance
- Double Gate FinFETs (Bulk Si vs. SOI)
  ; Bulk Si vs. SOI
  ; Speed superiority/ FinFET Design
- IC design with advanced FET (*e.g.* SRAM)
- Photonic Circuits

Components of photonic circuit: optical switch, on-chip light source, photonic modulator etc.
Fundamental-level introduction of photonic circuit simulation (FDTD solver)

Reference Textbook

Fundamentals of Ultra-This-Body MOSFETs and FinFETs, Jerry G. Fossum, Vishal P. Trivedi, Cambridge University Press 2013

Handouts and reference articles (for photonic circuits) developed by instructor will be downloaded.

Grading policy

(at least 75% attendance is required)

- Homeworks (2 times, one homework with any circuit simulation tools (e.g. LtSPICE, MATLAB, Cadence Virtuoso, etc.): 40%
- Technical presentation with the selective topics: 10%
- Practical exercise of Photonic circuit simulation – basic level: 20 %
- Final exam (open-note, take-home exam): 30%

Note: Students are expected to attend all scheduled sessions of the courses for which they are registered.

Note: Late submission of all assignments will carry a penalty of 10% per day with a maximum penalty of 50%. Extensions will NOT be allowed without prior permission from the instructor.