

ELEN 6304 (Fall 2009): Millimeter-Wave Integrated Circuits

The implementation of millimeter-wave (30GHz-300GHz) wireless systems in silicon-based technologies is an exciting research area that is less than a decade old. The design of mmWave ICs requires an interdisciplinary skill set that spans circuit design, electromagnetics and device physics. Through lectures, home-works and a final class project, this course will cover the principles of silicon-based mmWave IC design.

Topics that will be covered include:

- Introduction to mmWave systems and applications.
- Si-based devices for mmWave (Modern SiGe and CMOS technologies, f_T , f_{max} , current-density scaling, large-signal models).
- Si-based passive devices (Inductors, capacitors, resonators, transformers, transmission lines, impact of BEOL).
- mmWave amplifier design (Max. available gain, max. unilateral gain, cascade vs. cascode)
- mmWave and microwave low-noise amplifier design (CS, CB, $N_{F_{min}}$, Y_{opt} , noise circles).
- mmWave power-amplifier design (Class A-F, load-pull, efficiency/output power circles, impedance transformation and power combining).
- mmWave mixers for frequency translation.
- mmWave VCOs (LC oscillators, standing-wave oscillators, push-push and distributed oscillators).
- Oscillator phase-noise theory and its impact on mmWave VCO design.
- Injection locking, injection pulling and coupled oscillators.
- mmWave frequency synthesis (Regenerative dividers, injection-locked dividers, mmWave PLLs).
- Phased arrays and multiple-antenna systems (Architectures, phase-shifter circuits).

Grading

There will be regular HWs that constitute 10% of the final grade. The mid-term will constitute 25% and the final exam will be worth 35%. The class project will be worth 30%.

Date/Time

Tuesday/Thursday from 2:40-3:55pm.

Prerequisites

ELEN 4312 and ELEN 4314 or their equivalents at other universities. If you have questions regarding your eligibility to take this class, please contact the instructor.

Instructor

Prof. Harish Krishnaswamy (harish@ee.columbia.edu), CEPSR 1025.