

EEC 222 - RF IC Design

Units: 3

Course Structure: Lecture

Prerequisites: EEC210 and EEC132C

Quarter: Winter

Catalog Description: Understanding of radio frequency (RF) solid-state devices, RF device modeling and design rules; non-linear RF circuit design techniques; use of non-linear computer-aided-design (CAD) tools; RF power amplifier design.

Course Goals Students will gain fundamentals of RF IC design and be familiarized with RF IC design rules and non-linear computer-aided-design tools.

Expanded Course Description

1. Overview of high frequency integrated circuits
 - On-chip passive devices: resistors, capacitors and inductors
 - High frequency/high speed device physics and figures of merit
2. Solid-state device modeling and design rules
 - Review of small signal model and extraction techniques
 - Large signal model
 - Examples of nonlinear models
 - Examples of RF IC design rules and processes
3. Non-linear RF circuit design techniques
 - Harmonic balance analysis
 - Large-signal, single-tone problems
 - Solution algorithms
 - Selecting the number of harmonics and time samples
 - Generalized harmonic-balance analysis
 - Circuit envelope analysis
4. RF power amplifier design
 - Classes of power amplifiers
 - Review of linear amplifier design techniques
 - Gain match, power match, matching circuits for power amplifiers
 - Introduction to load-pull measurements
 - Conventional high efficiency amplifiers
 - Nonlinear effects in RF power amplifiers
 - Efficiency enhancement and linearization techniques

Reference Reading Materials

Stephen A. Maas, *Nonlinear Microwave Circuits*, IEEE Press, New York, 1997.

Steve C. Cripps, *RF Power Amplifiers for Wireless Communications*, Artech House, Massachusetts, 1999.

Thomas H. Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, Cambridge University Press, United Kingdom, 1998.

Grading

Projects (3) 60%

Final Exam 40%

Course Overlap

This graduate course covers practical RF circuit-level implementations of functional blocks for RF front-ends, especially transmitters. It exposes students to RF IC design, non-linear design techniques, RF power amplifier design, and the transmitter side of a RF front-end. Courses 228 and 211 cover noise analysis and some complementary RF circuits such as low noise amplifiers and receivers, without overlap.