

ENG EC582: RF/Analog IC Design Fundamentals

2008-2009 Catalog Data:

Prereq: ENG EC 412 and ENG EC 571 or consent of instructor. This course will teach the fundamentals of CMOS and SiGe BICMOS RF and analog circuit design techniques used in today's advanced mixed-signal integrated-circuit applications, such as a single-chip radio. Topics to be covered include RF chip design, oscillators, mixers, RF low-noise amplifiers, demodulators, phase-locked loops, RF power amplifiers, low power techniques, receiver and transmitter architectures, filters, and mixed-signal circuitry typical of modern telecommunications technology. VLSI laboratory exercises involving the design, layout, and simulation of RF/analog integrated circuits using Cadence SpectreRF CAD software tools. Hands-on laboratory experiments utilizing RF instruments at GHz frequencies. Real-world examples in advanced mixed-signal integrated circuit applications. 4 cr.

Status in the Curriculum: Elective

Class/Lab Schedule:

Lecture: 4 hours/week

Laboratory: 2 hours/week

Textbooks and other required materials:

T.H.Lee, The Design of CMOS Radio-Frequency Integrated Circuits, Cambridge, 2004 2nd edition.

Coleman, Introduction to Radio Frequency Engineering, Cambridge, 2004.

Johns and Martin, Analog Integrated Circuit Design, Wiley, 1997.

Reference:

Gray, Hurst, Lewis, and Meyer, Analysis and Design of Analog Integrated Circuits, Wiley, 2001.

Coordinator:

Ronald W. Knepper, Professor, ECE department

Prerequisites by topic:

EC412, EC571

Goals:

To provide the students with:

- * An understanding of analog and RF circuit design techniques
- * Knowledge of RF circuits utilized in modern RFIC and mixed-signal designs
- * Proficiency in the use of industry-standard IC computer-aided design tools
- * Experience in the design, simulation, and layout of real-world RF circuits
- * Experience in the use of state-of-the-art laboratory instruments for RF measurements

Course Outcomes:

As an outcome of completing this course, students should be able to:

- 1) possess a basic knowledge of RF circuitry used in telecommunication integrated circuits
- 2) understand the concepts of high frequency transmission lines and impedance matching
- 3) understand the methodology of using analog and digital modulation of an RF carrier
- 4) understand the basic superhetrodyne architecture utilized in RFIC applications
- 5) understand basic RF characterization utilizing gain, bandwidth, noise, phase noise, S-parameters
- 6) design and simulate basic RF circuits at the schematic level, using Cadence Spectre/RF CAD tools
- 7) design basic RF circuits at the chip level including layout and simulation with extracted models
- 8) demonstrate proficiency in the use of the IBM 0.18um 7WL design kit for RFIC design and simulation
- 9) demonstrate proficiency in the use of RF instruments, such as a network analyzer, spectrum analyzer, high freq oscilloscope, and noise figure measurements
- 10) possess the ability to read and understand current RF literature in publications such as IEEE JSSC

Course Outcomes mapped to Program Outcomes:

Program Outcomes:	a	b	c	d	e	f	g	h	i	j	k
Course Outcomes:	1-5	6-9	6-7	9	1-10	1,10	10	1-5,10	8-10	1-10	6-9
Emphasis:	5	5	3	4	5	3	5	3	4	5	5

1=not at all; 5=a great deal;

Topics in Project Assignments:

Lab 1: Use of Agilent Spectrum Analyzer to characterize a mixer and VCO

Lab 2: Design of a 4.5 GHz low noise amplifier

Lab 3: Design of an RF mixer

Lab 4: Design of an AM receiver front end

Reading: Read and write a report on a paper from IEEE Journal of Solid-State Circuits

Final Project: Design a direct-conversion transmitter at 5-GHz with 250mW output power

Contribution of Course to Meeting the Professional Component:

Engineering topics: 100%

Status of Continuous Improvement Review of this Course:

Date Last Reviewed:

March 27, 2007

Reviewed by:

ECE Graduate Committee (Prof. W. Oliver)

Prepared by: Ronald W. Knepper

Date: June, 2009