

14:332:464 RF Integrated Circuit Design

Course Catalog Description:

RF Integrated Circuit Design (3)

Basic concepts in RF design, analysis and design of RF circuits used in modern wireless systems

Pre-Requisite Courses: 14:332:361-Electronic Devices, 14:332:463-Analog Electronics

Co-Requisite Courses: None

Pre-Requisite by Topic: General knowledge on communications systems, semiconductor devices, transistor's frequency response, analog circuits, electromagnetics

Textbook & Materials:

-RF Microelectronics, 2nd Edition, by Behzad Razavi, Prentice Hall, ISBN: 978-0137134731

References:

- The Design of CMOS Radio-Frequency Integrated Circuits, by Thomas H. Lee, ISBN: 978-0521835398

Overall Educational Objective:

The objective of this course is to present the concepts of design and analysis of modern RF and wireless communication integrated circuits. Topics covered are: basic concepts in RF design, scattering parameters, modern integrated circuit technologies, fundamental limitations of speed of operation of transistors, physics of noise, impedance matching, low-noise amplifiers, mixers, oscillators, phase noise, and phase locked loops.

Course Learning Outcomes:

It is expected that the students be able to apply the concepts and design techniques presented in this course to a wide range of applications including high-speed wireless communications and biomedical electronics. A student who successfully fulfills the course requirements will have demonstrated:

1. an understanding of the concepts of RF design, linearity, noise, gain and dynamic range
2. an ability to do noise analysis in circuits
3. an ability to evaluate the performance of different communication transceiver architectures
4. an ability to design and simulate different blocks of RF communication circuits using modern IC technologies
5. an ability to work in a team, write technical documents and give oral presentations

How Course Outcomes are assessed:

| | |
|----------------|-----|
| Homework | 15% |
| Midterm Exam | 25% |
| Design Project | 25% |
| Final Exam | 35% |

| Outcome | | Proficiency Level assessed by |
|--|---|-------------------------------|
| (a) an ability to apply knowledge of Mathematics, science, and engineering | H | HW Problems, Exams, Project |
| (b) an ability to design and conduct experiments and interpret data | N | |
| (c) an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | S | Project |
| (d) an ability to function as part of a multi-disciplinary team | N | |
| (e) an ability to identify, formulate, and solve ECE problems | H | HW Problems, Exams. Project |
| (f) an understanding of professional and ethical responsibility | N | |

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|--|---|----|----------------------------------|
| (g) an ability to communicate in written and oral form | S | HW | Problems, Exams, Project |
| (h) the broad education necessary to understand the impact of electrical and computer engineering solutions in a global, economic, environmental, and societal context | N | | |
| (i) a recognition of the need for, and an ability to engage in life-long learning | S | HW | Problems, Project |
| (j) a knowledge of contemporary issues | N | | |
| (k) an ability to use the techniques, skills, and modern engineering tools necessary for electrical and computer engineering practice | H | HW | Problems, Exams, Project |
| Basic disciplines in Electrical Engineering | H | HW | Problems, Exams, Project |
| Depth in Electrical Engineering | H | HW | Problems, Exams, Project |
| Basic disciplines in Computer Engineering | N | | |
| Depth in Computer Engineering | N | | |
| Laboratory equipment and software tools | H | HW | Problems, Project |
| Variety of instruction formats | S | | Lecture, office hour discussions |

Topics Covered:

1. Basic Concepts in RF Design, Dynamic Range, Linearity, Noise Analysis, Scattering Parameters
2. Modern IC technologies (SiGe, CMOS), fundamental limitation of speed of transistors, Physics of Noise
3. Communication Concepts: Analog/Digital Modulation, Multiple Access Techniques
4. Transceiver Architectures, Heterodyne/Direct Conversion/Low-IF Receivers
5. Impedance Matching, RF Filters
6. Low Noise Amplifiers
7. Passive and Active Mixers
8. Oscillators, Basic Principles, Cross-Coupled, VCO, Phase Noise
9. RF Passive Components
10. Silicon-based receivers, Layout consideration, Packaging Issues
11. PLL

Computer Usage: Design and Simulations using Cadence Spectre Circuit Simulator

Design Experiences: Course design project

Independent Learning Experiences: 1. Homework, 2. Design Project

Contribution to the Professional Component:

(a) College-level Mathematics and Basic Sciences: 0.25 credit hours (b)

Engineering Topics (Science and/or Design): 2.75 credit hours (c)

General Education: 0.0 credit hours

Total credits: 3

