Integrated High Speed Communication Circuits

1 Course Description

Analysis and design of high-speed communication circuits for wireless and wire-line communications. Emphasis on understanding electromagnetic effects in silicon-integrated RF/microwave circuits. Study of noise, linearity, and bandwidth enhancement techniques in narrowband/broadband amplifiers. Emphasis on intuitive design methods, physical understanding, quantitative performance evaluation using both hand calculation and simulation. Understanding of technology limitations. Topics include passive devices' design and modeling, narrow-band and wide-band amplifier design, noise in communication circuits, design of low noise amplifiers, mixers, oscillators, power amplifiers, types of wireless transceivers, design of transimepdance amplifiers, clock and data recovery circuits, and wire-line transceiver architectures.

2 Prerequisite

Basic Analog Circuits (Introduction to Electronics/Analog Electronics ECSE-2050), Electromagnetic Basics (Field and Waves I ECSE-2100), Properties of Transistors (Microelectronic Technology ECSE-2210).

3 Topics Outline

Lecture	*Subject*
1	Course Overview, S-Parameters and the Smith Chart
2	RLC Networks, Integrated Passive Components
3	Transmission Lines, Transformer Modeling
4	High Frequency Transistors Modeling and Limitations
5	Broadband Amplifier Design
6	Distributed Circuits
7	Voltage and Current Biasing
8	The physics of Noise in Devices and Communication Systems
9	Low Noise Amplifiers–I
10	Low Noise Amplifiers –II
11	Mixers
12	Linearity in RF Mixers
13	Phase Noise in Oscillators
14	Voltage Controlled Oscillators–I
15	Voltage Controlled Oscillators –II
16	High Speed Frequency Dividers
17	Frequency Synthesizers
18	Clock and Data Recover Circuits-I
19	Clock and Data Recover Circuits-II
20	Power Amplifiers–I
21	Power Amplifiers-II
22	Basics of Wireless Transceivers
23	Wire-line Transceiver Architectures
24	Project Presentations
25	Project Presentations

4 References

1. Thomas H. Lee, "*The Design of CMOS RF IC*", Cambridge University Press, 1998.

2. Behzad Razavi, "*RF Microelectronics*, Prentice Hall, 1998.
3. Gray, Hurst, Lewis, and Meyer, "*Analysis and Design of Analog IC's*", Wiley and Sons, 2001.
4. John Rogers, Calvin Plett, "*Radio Frequency Integrated Circuit Design*", Artech House, 2003.
5. Rowan Gilmore, Les Besser, "*Practical RF Circuit Design for Modern Wireless Systems Vol. 2, Active Circuits and Systems*", Artech House, 2003.
6. Guillermo Gonzalez, "*Microwave Transistor Amplifiers: Analysis and Design*", Prentice Hall, 1996.
7. L. Herbert, C. W. Bostian and Frederick H. Raab, "*Solid State Radio Engineering*", Wiley and Sons, 1980.

5 Grading

Grading will be based on homework and a final project

- Homework (60%): Homework problems will range from mathematical/physical analysis of circuits to simulation/design of circuits using Cadence Spectre/Agilent ADS.
- Final project (40%): A list of projects will be announced after 1/3 of lectures are finished. Each group will submit a proposal and the last two lectures will have the project presentations. A final report will have analysis, design, simulation results, and possible testing methodology.
- Cooperation policy: Students can work in pairs on the homework, and turn in one write-up per pair.