|  |  |  |
| --- | --- | --- |
| **ECx532** | **RF Circuit Design** | **L-T-P: 0-0-3; Total 14Sessions** |

***Pre-requisite:*** Analysis and Design of Analog Integrated Circuits (EC664)

***Objectives:*** To provide knowledge of trans-receiver architectures design, and their various components.

***Topics Covered:***

1. **Introduction to RFIC Design:** Applications, Challenges, General Consideration in RF Design, Key RFIC Parameters and Specification. (5L)
2. **Transmitter and Receiver architectures:** Review of modulation schemes, Receiver architectures, Transmitter architectures, Link Budget and Communication Distance. (4L)
3. **Passive and active components for CMOS RFIC:** Review of MOSFET, RF transistor layout, CMOS process, Capacitors, Varactors, Resistors, Inductors, Transformers, Transmission lines Resonance, Matching, S-parameters. (6L)
4. **Noise and Nonlinearities:** Noise and Its Spectrum, Device Noise (Current Source and Voltage Source), Noise Figure, Noise Figure of Lossy Circuits, Noise Figure of Cascaded System, MOS Device Nonlinearity, Harmonic Distortion, Gain Compression Point, Inter-Modulation, Third Order Intercept Point, Cascaded Nonlinearity, Dynamic Range. (6L)
5. **Low Noise Amplifiers:** CMOS LNAs, Different Topologies, Noise Figure Calculation, Noise canceling LNAs, Matching and Stability. (6L)
6. **Mixers & Detectors:** Specifications, Active mixers, Passive mixers, Detectors. (4L)
7. **Oscillators and Frequency synthesizers:** Voltage Controlled Oscillator, Phase noise, Phase Locked Loops, Integer N synthesizers, Dividers. (6L)
8. **Power Amplifiers:** Basics and Class A, B, C, D, E, F and other configurations, Power combining, Linearity Improvement Techniques. (5L)

***Suggested Books:***

1. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd edition, Cambridge University Press,2003
2. Behzad Razavi, RF Microelectronics, Pearson Education India,2013
3. R. Ludwig, RF Circuit Design, 2nd edition, Pearson Education India,2011

***Course Outcomes:*** Upon successful completion of this course, students should be able to:

1. Apply the concepts and design techniques presented in this course to a wide range of applications including high-speed wireless communications.
2. Familiarity with the 50 ohm environment, RFIC Layout.
3. Understand the design bottlenecks specific to RF IC design, linearity related issues, ISI.
4. Identify noise sources; develop noise models for the devices and systems.
5. Specify noise and interference performance metrics like noise figure, IIP3 and different matching criteria.
6. Comprehend different multiple access techniques, wireless standards and various transceiver architectures.
7. Design various constituents’ blocks of RF receiver front end.