# GUJARAT TECHNOLOGICAL UNIVERSITY

**ELECTRONICS & COMMUNICATION (VLSI SYSTEM DESIGN) (42)**
RF CMOS IC DESIGN
**SUBJECT CODE:** 2724203
SEMESTER: II

**Type of course:** CMOS Design at RF Frequencies.

**Prerequisite:** Basics knowledge of CMOS Circuit Design

**Rationale:** Useful to understand the designing of CMOS IC Design for RF Applications.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | Practical Marks | | | | |
| | | | | ESE (E) | PA (M) | ESE (V) | | PA (I) | | |
| | | | | | | ESE | OEP | PA | RP | |
| 3 | 2# | 2 | 5 | 70 | 30 | 20 | 10 | 10 | 10 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs | % Weightage |
|---|---|---|---|
| 1 | **Introduction to RF Design and Wireless Technology:** Design and Applications, complexity and choice of Technology, Basic concepts in RF Design: Nonlinearity and Time variance, Inter-symbol Interference, random process and noise, sensitivity and dynamic range, conversion of gain and distortion. | 10 | 20 |
| 2 | **RF Modulation:** Analog and Digital Modulation of RF Circuits, comparison of various techniques for power efficiency, Coherent and non coherent detection, Mobile RF Communication and basics of Multiple Access techniques, Receiver and Transmitter architectures. Direct conversion and two-step transmitters. | 10 | 20 |
| 3 | **RF Testing:** RF Testing for heterodyne, Image reject, Direct IF and sub sampled receivers. | 04 | 15 |
| 4 | **BJT and MOSFET behavior at RF Frequencies:** BJT and MOSFET behavior at RF Frequencies, Modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation. | 10 | 20 |
| 5 | **RF Circuit Design:** Overview of RF Filter Design, Active RF Components and modeling, Matching and biasing Networks. Basic blocks in RF system and their VLSI implementation, Low noise Amplifier Design in various mixers-working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio frequency Synthesizers-PLLS, Various RF synthesizers architectures and frequency dividers, power amplifier design, liberalization techniques, Design issues in integrated RF Filters. | 14 | 25 |

**References Books:**

1. Thomas H. Lee “Design of CMOS RF Integrated Circuits” Cambridge University Press 1998.

2. B. Razavi “RF Microelectronics” PHI 1998.
3. R. Jacob Baker, H. W. Li, D.E. Boyce “CMOS Circuit Design, Layout and Simulation” PHI 1998.
4. Y. P. Tsividis “Mixed Analog and Digital Devices Technology” TMH 1996

**Course Outcome:**
After learning the course the students should be able to:

1. Understand the basic concept of RF in CMOS IC Design.
2. Understand the concept of different constrain, and optimization techniques of CMOS IC Design for RF Applications.
3. To understand various RF Components and their modeling.
4. Understand the concept of Testing in RF CMOS IC Design.
5. Understand the behavior of Active devices like BJT and MOSFET at RF Frequencies.

**List of Experiments:**

1. Introduction to RF CMOS IC Design, CAD Tools and SPICE Models.
2. To study Active RF Components and their modeling.
3. To design & implementation of CMOS Inverter at RF Frequency.
4. To design & implementation of CMOS Amplifier at RF Frequency.
5. To design & implantation of CMOS Low Noise Amplifier at RF Frequency.
6. To design & implementation of Voltage Controlled Oscillator at RF Frequency.
7. To design & implementation of RF Filter.
8. To study about various design issues in integrated RF Filters.
9. Seminar/Mini Project.

**Open Ended Problem**

1. Design and Simulation of Current Starved Voltage Controlled Oscillator.
2. Design of RF Low Pass Filter
3. Design of RF High Pass Filter
4. Design of RF Band Pass Filter
5. Design of RF Band Stop Filter

**Major Equipments:** Mentor Graphics, Tanner, Cadence, MATLAB Software**.**

**List of Open Source Software/learning website:**
Ng-spice
www.nptel.com
www.nptel.ac.in

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry

portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website