EC570 RF IC DESIGN (Elective IV)

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Courseobjectives:

- This course introduces the design of RF integrated circuits (RF ICs).
- RF IC's have rapidly advanced in both technology and design over the past 15 years to first create and then meet a high demand for cost effective solutions for mobile communication and ubiquitous access to information.
- Applications include wireless communications, active and passive remote sensing, location sensing, radar, and radio astronomy.
- This course is focused on the key concepts in having RF capability on a chip.
- CMOS technology and the ability to incorporate additional elements is emphasized.
- Parasitic effects and current device modeling will be explained.
- Using this foundation, the design of high-frequency, analog integrated circuits including low noise amplifiers, voltage-controlled oscillators, phase-locked loops, mixers and power amplifiers will be undertaken.
- Along with these specific building blocks, the critical concepts of impedance transformation, filtering, and power delivery will be addressed.

Course learning outcomes:

- Students successfully completing this course will be able to design and evaluate practical circuits for RF ICs from an intuitive approach based on a rigorous understanding of the fundamentals.
- They will have designed and simulated various circuit functions to implement the needs for RF IC used in many of the applications.
- They will be able to understand the relationship and limitations of circuit topology, device characteristics to achieving competitive specifications.

UNIT – I **(10 hours)**

Introduction

Introduction to Communication Circuits, Transmission media and reflections, Maximum power transfer, Passive RLC Networks for matching, Classical two-port noise theory, noise models for active and passive components, Noise figure, Friis equation, Nonlinearity and cascaded stages, Sensitivity and dynamic range, Passive impedance transformation.

UNIT – II **(10 hours)**

Low Noise RF amplifiers

High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, Cascode Amplifier.

Low noise amplifier design – LNA topologies, impedance matching, power match versus noise match, linearity and large signal performance, noise canceling LNAs, Constant gm biasing, current reusing technique

UNIT – III **(8 hours)**

Mixers

multiplier-based mixers, sub sampling mixers.

UNIT – IV **(9 hours)**

RF Power amplifiers

Class A, AB, B, C amplifiers,Class D, E, F amplifiers,RF Power amplifier design examples

UNIT – V **(8 hours)**

Voltage Controlled Oscillator

Resonators,Negative resistance oscillators

TEXT BOOKS:

1. Thomas H. Lee, Cambridge, The Design of CMOS Radio-Frequency Integrated Circuits, UK: Cambridge University Press, 2004.
2. Behzad Razavi, RF Microelectronics, Prentice Hall, 1998.

REFERENCES:

1. A.A. Abidi, P.R. Gray, and R.G. Meyer, Integrated Circuits for Wireless Communications, New York: IEEE Press, 1999.
2. Jeremy Everard, "Fundamentals of RF Circuit Design With Low Noise Oscillators",John Wiley & Sons Ltd.