The LNMIIT, Jaipur
Department of Electronics and Communication Engineering

Subject Code:	Course Title: **Advanced RF Engineering**	Total Contact Hours: **40**	**L: 3**	**T: 0**	**P: 0**	**C: 3**
Pre-requisite: Engineering Electromagnetics, Microwave Engineering		Year:1st	Semester: **Even**			
Type of Course: **XX**						

***** L → Lectures, T → Tutorials, P → Projects C → Credit***

Learning Objective:

The aim of this course is to inculcate the state-of-art in Radio Frequency (RF) and Microwave components, sources, detectors, radiating systems and measurement techniques in the students. As the course progresses, the students would get ample exposure to 3D Electromagnetic simulation tools to enhance their understanding of RF engineering. After the completion of the course, the students would be well versed in design and analysis of high frequency structures and communication systems.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		**Bloom's Level**
CO-1	**Classify**, **identify**, and **analyze** the behavior of different passive and active RF components generally used in Microwave circuits	**2, 3, 4**
CO-2	**Illustrate**, **classify**, and **evaluate** the functionalities of different RF components used to design and implement modern communication systems.	**2, 4, 5**
CO-3	**Build** and **analyze** passive RF and Microwave circuits such as filters, power dividers, and antennas using CAD tools.	**3, 4**
CO-4	**Compare**, and **appraise** various types of antennas, such as microstrip broadband and smart antennas, used in modern communication systems.	**4, 5**
CO-5	**Analyze** and **estimate** the different RF and microwave parameters of active and passive RF circuits using modern measurement equipment	**4, 5**
CO-6	**Extend** the knowledge to **build** and **analyze** RF systems used in current and futuristic modern communication systems	**2, 3, 4**

Course Topics		**Lecture Hours**
UNIT – I: Fundamental Components of RF Engineering		**16**
1.1 Review of conventional microwave components: 1.1.1 Resonators: Transmission line resonators, Cavity resonators, Dielectric resonators. 1.1.2 T- Junctions, Magic Tees and Wilkinson Power dividers 1.1.3 Hybrid Couplers	**3**	
1.2 Filter Design 1.2.1 Introduction to periodic structures and basics of filter design 1.2.2 Multifunction reconfigurable filters	**3**	
1.3 Sources and Active Circuits 1.3.1 Introduction to Sources: Low and high power RF sources 1.3.2 Detectors: Envelope detectors, Logarithmic Detectors 1.3.3 Small signal amplifier designs, stability analysis using stability	**5**	

circles 1.3.4 Low Noise Amplifiers and its integration with RF-frontend 1.3.5 Review of 5G Power amplifier design		
1.4 General analysis of RF oscillators, Voltage Controlled Oscillators (VCOs) 1.5 RF Phase-Locked Loops, Low Voltage RF Frequency Synthesizers	**5**	
UNIT – II:RF and Microwave Circuits Design Using Modern CAD Tools		**5**
2.1 Introduction to RF simulators (such as Dassault CST and Keysight ADS), Basics of RF Filter design and realization using lumped and distributed elements (Low pass, band pass, high pass, and band stop filters), Implementation using industry-oriented simulators	**2**	
2.2 Power divider- design and Implementation using simulator.	**2**	
2.3 Planar Antenna Design and Implementation using simulator.	**1**	
UNIT-III: Radiating systems for RF Communications		7
3.1 Review of Antennas and its use as an efficient matching element and Microstrip Patch Antenna (MSA)	**1**	
3.2 Broad Band Microstrip Patch Antennas: Achieving Broadband MSA design using air substrate, slot loading, and integrated reactive loading	**3**	
3.3 Smart Antenna 3.3.1 Benefits; Basic concepts of beam steering and beamforming; Adaptive array system 3.3.2 MIMO RF test and debugging techniques (Phase coherent MIMO)	**3**	
UNIT-IV: Advanced Microwave/ RF Systems and Measurement		
4.1 Network Analyzer – Scalar & Vector; construction; calibration technique – SOLT and TRL calibration; measurement procedure; Study of scattering parameter (S-parameters) for one and two port devices using Vector Network Analyzer (VNA).	**5**	**8**
4.2 Vector Signal Generators and Vector Signal Analyzers – construction, signal generation and measurement procedure and analyzing different parameters of microwave circuits using VSG and VSAs	**3**	
UNIT-V: State-of-the-art RF Design in 5G Communications		**4**
5.1 State-of-art RF circuits and architecture solutions for 4G/LTE-A/5G connectivity	**2**	
5.2 Energy efficient analysis and design of RF chains in 5G	**2**	

Textbook References:

Text Book:

1. Coleman, *An Introduction to Radio Frequency Engineering*, Cambridge, 2004.
2. T. H. Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, Cambridge, 2004.
3. B. Razavi, *RF Microelectronics, Prentice Hall*, 1998.
4. Luong and Leung, *Low Voltage CMOS RF Frequency Synthesizers*, Cambridge, 2004.

Reference books:

[1] R. S. Elliot, *Antenna Theory and Design*, Wiley.
[2] S. R. Saunders and A. R. Zavala, *Antennas and Propagation for Wireless Communication Systems*, Wiley.
[3] W. A. Stutzman and G. A Thiele, *Antenna Theory and Design*, Wiley.
[4] N. V. Carvalho, *Microwave and Wireless Measurement Technique*, Cambridge India.
[5] T. H. Lee, *Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits*, Cambridge University Press.
[6] M. Sucher and J. Fox, *Handbook of Microwave Measurements*, Vol.I, II, and III, John Wiley & Sons.
[7] Yan Li, *RF Front-End Circuits and Architectures for IoT/LTE-A/5G Connectivity*, 2018 Hindawi.
[8] Krister Andreasson, Richard Wallace, *Introduction to RF and Microwave Passive Components*, 2015 Artech House.
[9] Ignacio Llamas-Garro, Marcos Tavares De Melo, Jung-Mu Kim, *Frequency Measurement Technology*, 2018 Artech House.

Additional Resources:

1. Simulation tools: CST Microwave Studio, ADS
2. *TBD*

Evaluation Method	
Item	**Weightage (%)**
Quizzes (at least 2)	**10**
Assignment	**30**
Midterm	**20**
Final Examination	**40**

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	-	-	-	-	-	-	2	3	-	-
CO2	3	2	1	2	1	1	-	-	-	1	-	1	3	1	-
CO3	2	3	3	2	3	-	-	-	2	-	-	2	3	3	2
CO4	3	2	2	3	2	1	-	-	-	1	-	2	3	3	-
CO5	3	3	2	1	3	-	-	-	2	-	-	1	3	-	-
CO6	2	1	1	3	-	1	1	-	-	-	-	1	3	1	1

Last Updated On: 21-06-2021

Updated By: Dr. Suvadeep Choudhury **Approved By:**