GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (WIRELESS COMMUNICATION SYSTEMS & NETWORKS) (27)

RF CIRCUIT DESIGN

SUBJECT CODE: 2712706

SEMESTER: I

Type of course: Major Elective-I

Prerequisite: Basic Signal and systems, Basic circuit analysis, Microwave Engineering

Rationale:

This subject is designed to provide students with the basic principles of radio frequency (RF) circuit design. High frequency circuit behavior for analog systems as encountered in cell phones, base stations, transceivers (Bluetooth), and wireless LAN (WLAN) equipment is covered in this subject.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
4	2	2	6	70	30	20	10	20	0	150

Content:

Sr. No.	Contents	Total Hrs.	% Weightage
1	**Introduction to RF Electronics:** The Electromagnetic Spectrum, Microwave bands, RF behavior of Passive components, Tuned resonant circuits, Vectors, Inductors and Capacitors - Voltage and Current in capacitor circuits, Tuned RF / IF Transformers. High frequency limitations of BJT, MOSFET.	5	12
2	**Transmission Line Analysis:** Examples of transmission lines, Transmission line equations, Micro Strip Transmission Lines, Special Termination Conditions- sourced and Loaded Transmission Lines.	4	12
3	**Single And Multiport Networks:** The Smith Chart, Interconnectivity networks, Network properties and Applications, Scattering Parameters.	4	10
4	**Matching and Biasing Networks:** Impedance matching using discrete components, Micro strip line matching networks, Amplifier classes of Operation and Biasing networks.	5	12
5	**RF Passive & Active Components:** Filter Basics, Lumped filter design, Distributed Filter Design, Diplexer Filters, Crystal and Saw filters, Active Filters, Tunable filters, Power Combiners / Dividers, Directional Couplers, Hybrid Couplers, Isolators. RF Diodes, BJTs, FETs, HEMTs and Models.	6	16

6	**RF Transistor Amplifier Design:** Characteristics of Amplifiers, Amplifier Circuit Configurations, Amplifier Matching Basics, Distortion and noise products, Stability Considerations, Small Signal amplifier design, Power amplifier design, MMIC amplifiers, Broadband High Power multistage amplifiers, Low noise amplifiers, VGA Amplifiers.	6	16
7	**Oscillators:** Oscillator basics, Low phase noise oscillator design, High frequency Oscillator configuration, LC Oscillators, VCOs, Crystal Oscillators, PLL Synthesizer, and Direct Digital Synthesizer.	5	12
8	**RF Mixers:** Basic characteristics of a mixer, Active mixers, Image Reject and Harmonic mixers, Frequency domain considerations.	5	10

Reference Books:

1. 1. RF Circuit design: Theory and applications by Reinhold Ludwing, Pavel Bretchko. Pearson Education Asia Publication, New Delhi 2001.
2. Radio Frequency and Microwave Communication Circuits – Analysis and Design – Devendra K. Misra, Wiley Student Edition, John Wiley & Sons
3. Radio frequency and microwave electronics illustrated Mathew M.Radmangh, 2001, PE Asia Publication.
4. RF Circuit Design – Christopher Bowick, Cheryl Aljuni and John Biyler, Elsevier Science, 2008.
5. Secrets of RF Design by Joseph Carr., 3rd Edition, Tab Electronics.
6. Complete Wireless Design by Cotter W. Sawyer, 2nd Edition, Mc-Graw Hill.
7. Practical RF Circuit Design for Modem Wireless Systems Vol.2 by Less Besser and Rowan Gilmore.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Grasp basic knowledge of general RF circuits, components and systems.
2. Use Smith Chart in RF applications
3. Design impedance matching networks and passive RF filters
4. Understand two port networks and S-parameters
5. Understand RF receiver front end systems: RF amplifier, Mixer and Local oscillator for wireless communication systems.
6. Conduct experiments using simulation tools for RF circuit design.

List of Experiments:

1. Introduction to the Spectrum Analyzer
2. Spectral Analysis of Signal Harmonics.
3. Lab VIEW Harmonic Composition
4. The Passive Band-Stop Circuit with Load
5. The Passive Band-Pass Filter
6. Low Pass and High Pass Filter Generation
7. The Phase Shift Oscillator
8. The Hartley Oscillator
9. The Colpitts Oscillator
10. The Clapp Oscillator
11. Introduction to AM Communications
12. Modulation Index and Power Considerations

13. AM Signal Demodulation Techniques.
14. Double Sideband Analysis
15. Introduction to FM Modulation and Detection
16. Frequency Modulation
17. DC and AC Operating Point Analysis of an RF Amplifier
    (Use Multi-SIM or other similar CAD tools for above experiments)

Open Ended Problems:

- Design of wideband RF amplifier for Software Defined Radio
- Design of voltage controlled oscillator in the range of 600 MHz to 1200 MHz
- Build PLL frequency synthesizer for the frequency range of 1200 MHz to 1800 MHz and 1800 MHz to 2400 MHz.
- Design and simulate 2.4 GHz Low noise amplifier using 0.18µm CMOS technology

Major Equipment:

Following equipments are preferred in RF Circuit Design Laboratory

[1] RF Signal Generator

[2] Spectrum Analyzer

Software requirement:

Multisim software
Genesys (Agilent technologies)

List of Open Source Software/learning website:
www.nptel.ac.in