GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (COMMUNICATION SYSTEMS ENGG) (05)

RF AND MICROWAVES

SUBJECT CODE: 2710504

SEMESTER: I

Type of course: Major Elective - I

Prerequisite :Higher Engineering Mathematics, basic knowledge of Electromagnetic Field theory foundation level courses in Electronics Network Theory, Signals and Systems and Communication Systems Antenna theory and wave propagation ,Fundaments of semiconductor devices

Rationale: PG Students of EC Engineering need to possess good understanding of the fundamentals and applications of RF signals and Microwave engineering in wireless communication , microwave frequency operated devices and appliances .They can identify role of microwave semiconductors, solid state devices and MMIC fabrication technology in microwave design. They are expected to be able to design RF frequency/microwave transmission line, coupler, power divider, amplifiers, Resonators, Mixer, oscillators and matching networks. They will be practiced in high frequency analysis and synthesis using S-parameter and microwave measurements. They will be able to design microwave communication system.

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	
3	0	2	4	70	30	20	10	20	0	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**TWO PORT RF NETWORKS-CIRCUIT REPRESENTATION:** Low frequency parameters-Impedance and Admittance, Hybrid and ABCD parameters, High frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and Lossless networks, Transmission matrix, Introduction to component basics, wire, resistor, capacitor and inductor, Applications of RF.	9	20
2	**RF TRANSISTOR AMPLIFIER DESIGN AND MATCHING NETWORKS:** Amplifier power relation, Stability considerations, Gain considerations, Noise figure, Impedance matching networks, Frequency response, T and Π matching networks, Microstripline matching networks.	9	20
3	**MICROWAVE PASSIVE COMPONENTS:** Microwave frequency range, Significance of microwave frequency range: Applications of microwaves, Scattering matrix: Concept of N port scattering matrix representation, Properties of S matrix, S matrix formulation of two-port junction, Microwave junctions: Tee junctions, Magic Tee, Rat race, Corners, Bends and Twists, Directional couplers: Two hole directional couplers, Ferrites: Important microwave	9	20

	properties and Applications, Termination: Gyrator, Isolator, Circulator , Attenuator, Phase changer, S Matrix for microwave components: Cylindrical cavity resonators.		
4	**MICROWAVE SEMICONDUCTOR DEVICES:** Microwave semiconductor devices: Operation, Characteristics and application of BJTs and FETs, Principles of tunnel diodes, Varactor and Step recovery diodes, Transferred electron Devices, Gunn diode, Avalanche Transit time devices, IMPATT and TRAPATT devices, Parametric devices: Principles of operation, Applications of parametric amplifier .Microwave monolithic integrated circuit (MMIC):Materials and fabrication techniques.	9	20
5	**MICROWAVE TUBES AND MEASUREMENTS:** Microwave tubes: High frequency limitations, Principle of operation of Multicavity Klystron, Reflex Klystron, Traveling Wave Tube, Magnetron. Microwave measurements: Power, Wavelength, Impedance, SWR, Attenuation, Q and Phase shift.	9	20

Reference Books:

1. Samuel Y. Liao: Microwave Devices and Circuits - Prentice Hall of India, 2006.
2. Reinhold.Ludwig and Pavel Bretshko 'RF Circuit Design", Pearson Education, Inc., 2006.
3. Robert .E. Collin: Foundations for Microwave Engg- Mc Graw Hill. (2001)
4. M.M.Radmanesh, RF & Microwave Electronics Illustrated, Pearson Education, 2007.
5. David M.Pozar: Microwave Engg. - John Wiley & Sons - 2nd Edition (2006)
6. Annapurna Das and Sisir K.Das: Microwave Engineering - Tata McGraw-Hill (2004)

Course Outcome:

By the end of this course, the student should be able to do the followings

1. To identify role of RF/Microwave engg. in communication and other field.
2. To analyze low and high frequency parameters of two port RF Networks and represent in circuit form.
3. To design RF transistor amplifiers and matching networks.
4. To Design frequency-selective digital filters.
5. To Design digital filters using windows.
6. To Sample and reconstruct analog signals.
7. To formulate S-matrix for n-port junction, microwave components and cylindrical cavity resonators.
8. To classify, identify and operate semiconductor devices according to their characteristics.
9. To identify advantage and improvement of MMIC technique over conventional fabrication technique
10. To design and operate microwave tubes, amplifiers and oscillators.
11. To identify high frequency limitations to design microwave devices.
12. To measure power, wavelength, impedance, SWR, attenuation, Q and phase shift in microwave.

List of Experiments:

1. To study V-I characteristics of Gunn Diode.
2. To determine the frequency and wavelength in a rectangular waveguide working on TE10mode.
3. To determine the standing wave ratio.
4. To study about characteristics of the Reflex Klystron Tube.
5. To find coupling factor, Isolation, Directivity and Insertion Loss, main line and auxiliary line VSWR for multi-hole directional coupler.
6. To measure input and output power for H-palne, E-plane and Magic tee.
7. To find insertion and isolation loss for circulator and isolator.
8. To find insertion loss for attenuator.
9. To find insertion and isolation loss in directional coupler.

10. To find insertion and isolation loss for various bends.

Open Ended Problems:

1. Design a GaAs FET amplifier for maximum gain at 4.0 GHZ.
2. Design a GaAs FET amplifier having a 2.0 dB noise figure with the maximum gain that is compatible with noise figure.
3. Design load matching network for 50Ω load impedance.
4. Design a transistor oscillator at 4 GHz using a GaAs FET. Choose a terminating network to match to a 50Ω load, and appropriate tuning network.
5. A wieless local area network application require a local oscillator operating at 2.4 GHz. Design a dielectric resonator oscillator using bipolar transistor. It should include matching network for output termination.
6. Design matching network to match broader load variable range with minimum reflection co-efficient value.
7. Design optimum resonator with best values of operating frequency and quality factor.

Major Equipments:

Microwave Test Bench and components

List of Software:

IE3D, ADS, Microwave CAD

Learning website:

www.nptel.ac.in