GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (COMMUNICATION SYSTEMS ENGG) (05)

MICROWAVE INTEGRATED CIRCUITS

SUBJECT CODE: 2740503

M.E. 4TH SEMESTER

Type of course: Major Elective-V

Prerequisite: Higher Engineering Mathematics, Specifically students should be familiar with analysis and design techniques of basic RF circuits as well as microwave frequency electronic devices (particularly diodes and transistors) and related circuits. Understanding phasors and their application in transmission lines and microwave circuits, basic microwave circuit elements, circuit theorems, poynting theorem and vector, average power, effective and complex power, analyzing and solving linear microwave circuits is the main prerequisite for taking this course.

Rationale:

PG Students of EC Engineering need to possess good understanding of the fundamentals and applications of Microwave Integrated Circuits technology, comparisons with conventional, analysis of microwave distributed circuit elements, analysis of RF and Microwave circuit elements, analysis of transmission line circuits and Microstrip lines, analysis of S-parameters and network characterization techniques, use ZY Smith chart to design microwave matching networks, use of stability circles, stability criteria to solve stable and potentially unstable networks, design microwave small signal and power amplifiers, design microwave oscillators, design microwave detectors and mixers, design microwave control circuits, microwave integrated circuits (MICs), MIC processing techniques.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
L	T	P	C			ESE	OEP	PA	RP	
4	0	2#	5	70	30	20	10	10	10	150

Content:

Sr No.	Content	Total Hrs	% weightage
1	**Hybrid MICs :** Definition, characteristics, comparison with conventional circuits, fields of application and limitations and criteria for the choice of substrate material; thin film hybrid circuits, thick film hybrid circuits, artwork, mask making, photolithography, resistor stabilization, sawing, brazing process, wire bonding.	9	20 %
2	**Monolithic MICs:** Definition, substrate structure, doping by ion implantation ohmic contact, metal resistive layers, gate metal, dielectric second level metal, dielectric and air bridge vias, substrate vias, final wafer process steps.	9	20 %
3	**Micro strip Lines:** Planar wave guides, non- TEM propagation, line impedance definitions, quasi-static approximations, quasi-static line parameters, micro strip open circuits and gaps, micro strip corners, step changes in width, dispersion analysis, micro strip characteristic impedance, symmetric T junction, full wave analysis of micro strip propagation, LSE and	9	20 %

	LSM potentials, spectral domain analysis, dispersion relation for open micro strip, spectral domain impedance analysis, dispersion relation for open micro strip, spectral domain impedance analysis, Green's functions, millimeter wave modeling of micro strip lines.		
4	**Coupled Line Propagation:** Wave equations for coupled lines, propagation models, coupled line parameters, coupled line parameter variations with frequency, directional couplings, Lange coupler coupled line pair treated as a four port, coupled line pair operated as a two port assuming Oe = 0o, low pass filtel design assuming Oe =0o, coupled line pair analyzed to a two port Oe not equal to 0o, narrow band filter using coupled resonator, narrow band coupled line filters, suspended substrate strip lined filters, suspended substrate strip line filter design using method 1 and method 2.	9	20 %
5	**Slot Lines:** Analysis, design consideration, transitions and applications. **Coplanar Waveguide:** Analysis, design considerations and coplanar line circuits. **Devices:** GaAs FET, HEMT, gunn diode, varactor diodes, PIN diodes YIC resonators, dielectric resonators & their application in oscillator mixer and amplifiers.	9	20 %

Reference Books:

1. Microstrip Circuit Analysis - David H. Schrader, Prentice Hall PTR, New Jersey
2. Microstrip lines and Slot lines- KC. Gupta, R. Gargand I.J. Bahl , Artech House.
3. MIIC Design: GaAs FETs and HEMTs- Peter Ladbrooke ,Artech House.
4. Foundations for Microstr!p Circuit Design -T.C. Edwards,John Wiley and Sons
5. MIC and MMIC Amplifier and Oscillator Circuit Design- Allen Sweet, Artech House.
6. Handbook of Microwave Integrated Circuits- Reinmut K Hoffman, Artech House.
7. Samuel. Y. Liao, “Microwave Circuit Analysis and Amplifier Design”, Prentice Hall. Inc.,1987.
8. B.Bhat and S.Koul, “Stripline Like transmission lines for MICS”, John Wiley, 1989
9. T.C.Edwards, “Foundations for Microstrip Circuit Design (2/e)”, Wiley, 1992.
10. Ravender Goyal, “Monolithic MIC; Technology & Design”, Artech House, 1989.
11. Gupta K.C. and Amarjit Singh, “Microwave Integrated Circuits”, John Wiley, New York, 1975.

Course Outcome:
After completing this course the student must demonstrate the knowledge and ability to:

1. Understand microwave distributed circuit elements.
2. Understand RF and Microwave circuit elements.
3. Understand microwave circuit analysis techniques.
4. Understand transmission line circuits and Microstrip lines.
5. Understand S-parameters and network characterization techniques.
6. Apply the ZY Smith chart to design microwave matching networks.
7. Apply stability circles, stability criteria to solve stable and potentially unstable
1. networks.
8. Design microwave small signal and power amplifiers.
9. Design microwave oscillators.
10. Design microwave detectors and mixers.
11. Design microwave control circuits.
12. Understand microwave integrated circuits (MICs).
13. Understand MIC processing techniques.

List of Experiments:

Sr. No.	Experiment Name
1	Introduction to Agilent ADS simulation software tool.
2	Microwave Measurements - Spectrum Analysis using ADS.
3	MMIC Planar Spiral Balun Design using Keysight ADS.
4	MMIC Mixer Design and Simulation using Keysight ADS.
5	Design an RF Power Amplifier using ADS.
6	Design Microwave voltage controlled oscillator using ADS.
7	Design MMIC Mixer and Simulation using ADS.
8	Design Microstrip Filter using ADS.
9	Designing mm-wave integrated filters using Keysight ADS.
10	Design of a Broadband MMIC Frequency Doubler using ADS.

Design based Problems (DP)/Open Ended Problem:

1. Design uniplanar 3-dB hybrid coupler for microwave integrated circuits (MIC) and monolithic MIC (MMIC) applications, isolation is greater than 30-dB and the return loss better than 18.2-dB over a 2% bandwidth centered at 1.46 GHz also insertion loss for this passive component is 0.5 dB at 1.46 GHz
2. Design millimeter wave voltage-tunable source with an output of 10 mW from 31.8 to 33.4 GHz and second source with voltage tunable from 8.7 to 9.7 GHz with an output power greater than 10 mW.
3. Design 10 GHz double barrier tunneling diode microwave integrated circuit oscillator using Microwave integrated circuit technology.
4. Micromachined on-chip RF passive bandpass filters at 1-8 GHz based on utilizing a three-pole *LC* low-pass filter and two dc-blocking capacitors, using GaAs monolithic-microwave-integrated-circuit process, using planar spiral inductor in the design, the layout size of filter should be less than 700μm × 400μm.

Major Equipment:

Spectrum Analyzer, Network analyzer, Network Synthesizer, Microwave source generator

List of Software:

Agilent keysight ADS tool

List of Open Source Software:

Learning website:

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.