GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Electronics & Communication (Communication System Engineering)

Course / Subject Code : ME01000341

Course / Subject Name : RF and Microwave Circuit Design

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Signals and Systems, Digital Signal Processing
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, Mixers, oscillators and matching networks. They will be able to perform high frequency analysis and synthesis using S-parameters and microwave measurements. They will be able to design microwave communication system.

Course Outcome: After Completion of the Course, Student will able to**:**

No	Course Outcomes	RBT Level
01	Understand the behaviour of RF passive components and model active components.	U
02	Perform transmission line analysis.	N
03	Demonstrate use of Smith Chart for high frequency circuit design.	A
04	Justify the choice/selection of components from the design aspects.	E
05	Contribute in the areas of RF circuit design.	C

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Transmission Line Theory**: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.	9	20
2.	**Microwave Network Analysis**: Impedance and equivalent voltage and current, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.	9	20
3.	**Microwave Components**: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.	9	20
4.	**Microwave Semiconductor Devices And Modeling**: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, and HEMT.	9	20
5.	**Amplifiers Design**: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators, Mixers design.	9	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**20**	**20**	**20**	**10**	**20**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design", Author House, 2009.
2. D.M.Pozar, "Microwave engineering", Wiley, 4th edition, 2011.
3. R.Ludwig and P.Bretchko, "R. F. Circuit Design", Pearson Education Inc, 2009.
4. G.D. Vendelin, A.M. Pavoi, U. L. Rohde, "Microwave Circuit Design Using Linear And Non Linear Techniques", John Wiley 1990.

5. S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.
6. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education, 2004.

(b) Open source software and website:

- ADS
- https://nptel.ac.in

Suggested Course Practical List: (30 Hours)

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 measure input and output power for H-palne, E-plane and Magic tee.
5. To design and simulation of short circuited Ideal Transmission line using ADS
6. To design and simulation of open circuited ideal transmission line using ADS
7. To design and simulation of short circuited microstrip Transmission line using ADS
8. Design and simulation of Band Pass Filter using ADS.
9. Design and simulation of Low pass Filter Using ADS.
10. Design and simulation of directional coupler using ADS.
11. Design and simulation of power divider using ADS.
12. Design a GaAs FET amplifier for maximum gain at 4.0 GHZ.
13. Design a GaAs FET amplifier having a 2.0 dB noise figure with the maximum gain that is compatible with noise figure.
14. Design an impedance transforming network using two element L matching circuit that matches a generator resistance of 400 Ω to a load resistance is 20 Ω. The centre frequency for the circuit is 6MHz.
15. 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. Power GaAs FETs, MESFET, MOSFET, HEMT 5 Microwave Components: Microwave resonators: Rectangular Cavity Resonator, Cylindrical Cavity Resonator, Power dividers: T Junction Power divider, Wilkinson Power Divider and directional couplers: Waveguide Directional Coupler, Lange Coupler, Ring Hybrid Coupler. 9 20 Total 45
16. A wireless 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.
17. Design matching network to match broader load variable range with minimum reflection coefficient value.
18. Design optimum resonator with best values of operating frequency and quality factor.

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