BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI- HYDERABAD CAMPUS
INSTRUCTION DIVISION, FIRST SEMESTER 2016-2017
COURSE HANDOUT PART II

Date: 19 –07 - 2016

In addition to Part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No.	**:**	**EEE G581**
Course Title	**:**	**RF and Microwave Engineering**
Instructor-in-charge	**:**	**Dr Runa Kumari**
Instructors	**:**	**Dr Runa Kumari**

1. Course description:

Maxwell's equations, Boundary conditions, Wave propagation, Poynting theorem; Electrical properties of materials; Transmission line theory, impedance matching, and transmission line resonators; Wave propagation in Waveguides - rectangular and circular, non-TEM modes, dominant mode, higher order modes, Waveguide components; Cavity resonators, Equivalent circuit model, Metallic and Dielectric resonator cavities; Image theory, Equivalence principle, Perturbation theorem; Multiport network parameters, S-parameters, Signal flow graphs, Vector network analyzer (VNA) - block diagram; Power divider and directional couplers; Microwave solid state devices and travelling wave tubes; Microwave generators; Computational electromagnetism

2. Scope & Objective:

This course deals with radio frequency and microwave engineering, which in other words is the physical realization of electromagnetic theory. The basic knowledge of the student in the field of engineering electromagnetics will be developed to advanced levels. Low frequency systems can be analyzed using *circuit theory*, where concepts like *voltage*, *current* and *impedance* are valid. At intermediate frequencies, the analysis needs inclusion of an additional effect called *reflection* into circuit theory, which now becomes the *transmission line theory*. But at high frequencies, the circuit / transmission line theory has to be replaced with *field theory*, in order to address the new effect of *radiation*. Practical uses of certain theorems based on *field theory* will be described. Commercial electromagnetic simulators will be introduced and the underlying electromagnetic principles will be revisited. Students are supposed to approach the course from a research point of view also. In addition to relying on the subject oriented textbooks, the students are advised to follow technical journal papers also. Skills like preparing and presenting technical report, seminar, etc., will also be developed and evaluated.

3. Text Books

(i) Pozar, David M Microwave Engg. WSE , 3rd ed , 2005

(ii) Liao, S Y Microwave Devices & Circuits PHI/ Pearson Edu. , 3rd ed , 1990

(iii) Singh,Hema & S.Balasubramanian RF & Microwave Engineering Notes-EDD, 2006

4. Reference Books

[R1] C.A. Balanis, Advanced Engineering Electromagnetics, John Wiley, 1989

[R2] S.L. Liao, Microwave devices and circuits, Pearson Education, 3rd Ed., 1997

[R3] R.E. Collin, Foundations for Microwave Engineering, 2nd Ed. Wiley India, New Delhi 2005

4. Course Plan

Sl.No	Topics to be covered	Learning Objectives	Ref. to Book	No. of Lectures
1	Introduction to the course and its components	Course handout discussion		1
2	Divergence, Curl, Gradient, and Laplacians; Divergence and Stokes' Theorems; Introduction to Curvilinear Coordinate Systems	Review of Vector Calculus	Lecture Material (LM)	1
3	Electrostatics, Magnetostatics, Time Harmonic EM Fields (including Maxwell's equations), Boundary Conditions	Review of Electromagnetic Fields	T1 : ch.1	3
4	Helmholtz Wave Equation, Lossy Materials and Complex Permittivity, Poynting Vector, Wave Transmission and Reflection	Basics of Wave Propagation	T1 : ch.1	4

5	Free Space as a TX Line, TX Line Terminated with a Load, Some Special Cases, Smith Chart, Impedance Matching, Lumped Element Circuit Model of a TX Line	Transmission Line Theory	T1 : ch.2, ch.5	5
6	Implementation of Capacitors and Inductors at Microwave Frequencies, Basic Theory of Series and Parallel Resonators, TX Line Resonators	TX Line Resonators	T1 : ch.6	2
7	Review of Helmholtz Wave Equation; TE, TM, and TEM Modes (in both rectangular and cylindrical coordinate systems); Rectangular and Circular Waveguides; Planar TX Lines such as Microstrip Lines	Waveguides and TX Lines	T1 : ch.3	4
8	Cavity Resonators, Dielectric Resonators, Excitation of Resonators	Cavity & Dielectric Resonators	T1 : ch.6	2
9	Typical N-Port Parameters (such as Z, Y, ABCD, etc.); S Parameters; Reciprocal, Loss-less, Matched Networks; Even & Odd Mode Analysis; Analysis of Cascaded and Interconnected Microwave Networks; Qualitative Analysis of Equivalent Impedance, Voltage, and Currents; Discontinuities and Bends in TX Lines	Microwave Network Analysis	T1 : ch.4	5
10	Basic theory of Power Dividers and Couplers, 3-Port vs 4-Port Devices; 3-Port Power Dividers such as T-Junctions, Wilkinson Power Divider, etc.; 4-Port Devices such as Quadrature Hybrid Coupler, Rat-Race Coupler, etc.; Qualitative Treatment of a few Other Types of Couplers	Power Dividers and Directional Couplers	T1 : ch.7	5
11	Solid State Sources : Gunn Diode - GaAs, InP Diode Oscillators, IMPATT Diode; Tube based Amplifiers and Sources - Klystron, Magnetron, Travelling Wave Tube, etc.	Microwave generators	T1 : ch.10 T2 : ch.7--9	5
12	Introduction to Time Domain and Frequency Domain Techniques; Basic ideas of FDTD, FEM, and MoM Techniques.	Computational Electromagnetics	Lecture Material	5
		Total Number of Lectures		42

Laboratory component: One lab session per week**.** Laboratory component involves hardware as well software (both circuit and full-wave simulations using Ansys Electronic Desktop) experiments.

6. **Evaluation Scheme**

Component	Duration	Weightage	Date & Time	Remarks
Test I	60 min	15%	13/09 & 10:00- 11:00AM	Closed Book
Test II	60 min	15%	21/10 & 10:00- 11:00AM	Closed Book
Comprehensive Theory Exam	3 Hrs	30%	14/12 FN	Closed Book
Regular Lab	--	15%		Open Book
Term Project	--	20%		Open Book
Lab Exam.	----	5%		Open book

7. **Chamber Consultation Hour**: Will be announced in the class.

8. **Notices**: Notices concerning this course will be on CMS.

Runa Kumari
Instructor-in-Charge