ECE332: ENGINEERING ELECTROMAGNETICS

Programme: B. Tech. Year: 3^{rd} Semester: I
Course: Core for ECE Credits: 3 Hours: 40

Course Context and Overview (100 words):
The primary objective of the course is to provide students with an in-depth understanding of the fundamental principles of electromagnetism, and to apprise them of electromagnetic theory's most common applications in the world of electronics engineering. The secondary objective of the course is to make students sufficiently familiar with transmission-line theory and its applications in real world.

Prerequisites Courses: NIL

Course Outcomes(COs):

On completion of this course, the students will have the ability to:
CO1: Should be able to derive ABCD-, Z-, and Y-parameters for a given network and should have the ability to use logarithmic units.
CO2: Should be able to use analytical equations and Smith Chart for determining transmission line performance parameters like SWR, reflection coefficient, input impedance, transmitted power, attenuation constant, phase constant, complex propagation constant, etc.
CO3: Should be able to use Maxwell's equations and boundary conditions for analyzing the behavior of plane waves in various types of media, and to find the nature of polarization of a given electromagnetic wave.
CO4: Should be able to analyze rectangular waveguides, circular waveguides, and coaxial lines.
CO5: Should be able to analyze Microwave Integrated Circuit (MIC)-based transmission lines, especially striplines and microstrip lines.

Course Topics:

Topics	**Lecture Hours**	
UNIT - I 1. **Basics** 1.1. Logarithmic units like Neper, dB, dBm, dBW for measuring gain, power and attenuation, Signal to Noise Ratio (SNR) and Noise Figure (NF), lumped versus distributed elements	2 2	4

1.2. Two-port circuit parameters, inter-parameter conversions, network parameters for series, parallel, and cascaded networks		
2. **Transmission Lines**		8
2.1. Analysis		
2.1.1. Primary constants, lumped equivalent circuit for elemental section, derivation of transmission line equations, secondary constants, complex propagation constant, attenuation constant, phase constant, characteristic impedance, lossless versus lossy lines, distortion-less line, line impedance, input impedance, infinitely-long line, matched line	4	
2.2. Standing Waves		
2.2.1. The formation of standing waves, reflection coefficient, Standing Wave Ratio (SWR), voltage/current maxima and minima along the line length, power transmitted to load	1	
2.2.2. Input impedance for open-circuited and short-circuited lines and their role in realizing inductors and capacitors at high frequencies	1	
2.3. Smith Chart		
2.3.1. Basic derivations, constant-resistance circles, constant-reactance circles, numerical examples illustrating the use of Smith Chart	2	
UNIT - II 3. **Maxwell's equations, boundary conditions, and plane waves**		4
3.1. Maxwell's equations and boundary conditions		
3.1.1. Constitutive relationships for dielectric, magnetic, and conducting materials, loss angle and loss tangent, polarization inside the material under the influence of an externally-applied field, complex permittivity and complex permeability, derivations of Maxwell's equations from basic laws like Faraday's law, Ampere's law, and Gauss' law, behavior of tangential and normal electric/magnetic field components at the interface of two different media	4	
4. **Plane waves**		8
4.1. Uniform plane waves in free-space, wave equation, the concept of transverse electromagnetic (TEM) mode, phase velocity, equi-phase surfaces, group velocity, phase constant, intrinsic impedance	2	
4.2. Uniform plane waves in lossless dielectrics, uniform plane waves in lossless magnetic media, uniform plane waves in lossy dielectrics, uniform plane waves in good conductors, skin depth, attenuation constant, phase constant, and effective intrinsic impedance	2	
4.3. Non-uniform plane waves in free-space, the use of the method of separation of variables for solving the 'generalized' wave equation	2	
4.4. The concept of wave polarization (linear, circular, elliptical), the reflection and refraction of plane waves at the interface of two different media, the concept of Poynting Vector	2	
UNIT - III 5. **Rectangular Waveguides**		8
5.1. Transverse Electric (TE) mode analysis	3	
5.2. Transverse Magnetic (TM) mode analysis	2	
5.3. Performance parameters like cutoff frequency, guide impedance, propagation constant, phase velocity and group velocity, fundamental mode and higher-order modes	2	

5.4. Power handling capability and equations for conductor loss and dielectric loss	1	
UNIT - IV 6. **Circular Waveguides**		5
6.1. Circular Waveguide: Transverse Electric (TE) mode analysis	2	
6.2. Circular Waveguide: Transverse Magnetic (TM) mode analysis	1	
6.3. Circular Waveguide: Performance parameters like cutoff frequency, guide impedance, propagation constant, phase velocity, and group velocity, fundamental mode and higher-order modes	1	
6.4. Circular Waveguide: Power handling capability and equations for conductor loss and dielectric loss	1	
7. **Coaxial Lines and Microwave Integrated Circuits (MICs)**		5
7.1. TEM mode analysis for coaxial line	2	
7.2. Higher-order mode analysis for coaxial line	1	
7.3. Introduction to Microwave Integrated Circuits (MICs): striplines, microstrips, slotlines, coplanar waveguides, and coplanar strips	2	

Text Books:

1. Raghuvir S. Tomar, "*E-notes*", The LNM Institute of Information Technology, Jaipur, 2014.
2. Edward C. Jordan and Keith G , *"Electromagnetic Waves and Radiating Systems"*,. Balmain, Second Edition, PHI Learning Private Limited, New Delhi, 2011.
3. David M. Pozar,"*Microwave Engineering"*, Third Edition, Wiley-India, 2010.

Reference books:

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

Evaluation Methods:

Item	Weightage
Quiz (at least 5 quizzes) Continuous evaluation	25%
Mid-term Examination(90 minutes)	25%
End-term Examination(180 Minutes)	50%