BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

INSTRUCTION DIVISION
FIRST SEMESTER 2018-2019
Course Handout Part II

Date: 02/08/2018

Course No. : **EEE/INSTR F212**
Course Title : **ELECTROMAGNETIC THEORY**
Instructor in charge : **PRAVEEN KUMAR A.V. (Chamber : 2210-D, email : praveen.kumar@pilani.bits-pilani.ac.in)**
Instructors : **Mr. Ashish Patel, Mr. Harshvardhan, Dr. Mahesh Angira, Dr. Nilanjan Chattraj**

1. Course Description

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; electrostatic problems, Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Inductance; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space, Poynting theorem, Wave incidence, Flow of electromagnetic power, Unguided and guided fields, Reflection and transmission, Transmission lines, Impedance matching, Smith chart, Antenna fundamentals

2. Scope, Objectives and Learning outcomes of the course

Electromagnetic theory is a basic course that deals with the principles of electromagnetism, mainly the effects of electricity and magnetism in individual and combined forms subjected to certain geometrical and material constraints. The course is essential for the understanding of many pertinent phenomena in Electrical, Electronics and Communication Engineering, as all these fields involve the manipulation of the fundamental source of fields - *the charge*. In the early lectures, basic mathematical laws and theorems governing static and steady fields will be reviewed. Later, basic laws will be combined to develop techniques that help solve complex problems. In the end, practical applications such as transmission lines and antennas will be explored. This course will also serve as a precursor to advanced courses such as the *RF and Microwave engineering* and *Antenna Theory and Design* that deals with system design at higher radio frequencies.

After completing the course, students will be able to,

1. Use the *Del* (∇) operator and its variants to characterize a given field
2. Transform fields between various coordinate systems
3. Calculate the fields in space due to an arbitrary source distribution
4. Understand the basic laws involving static and dynamic fields
5. Use boundary conditions to solve fields in various media
6. Differentiate among various electromagnetic media / materials
7. Express Maxwell's equations in various forms
8. Describe the effects of oscillating charges / fields
9. Explain the field buildup and power flow through free-space, cables etc
10. Identify various transmission lines and antennas
11. Use Smith chart to solve transmission line problems

3. Text Book

T1. David K. Cheng, "Field and Wave Electromagnetics" 2nd ed. Pearson Education, New Delhi, 2009.

Reference Books

R1. Matthew N. O. Sadiku, "Principles of Electromagnetics" 4th ed. Oxford University Press, New Delhi, 2013
R2. William H. Hayt, "Engineering Electromagnetics", 8th Ed., McGraw Hill Education, New Delhi, 2014

4. Lecture Plan

Approx. Lecture Number	Main Topic	Main Contents	Reference from T1
1	Course handout discussion	Introduction to the course and its components, Applications and scope.	Lecture slides
2-7	Vector calculus and related theorems	Review of mathematical tools - Scalar and vector fields, Coordinate systems and Transformations, Calculus in Cartesian and curvilinear coordinates, Gradient, Divergence, Curl and Laplacian operations, Line, Surface and Volume integrals, Divergence theorem, Stoke's theorem	Ch.2 (2.1-2.12)
8-13	Electrostatics	Review of basic concepts –Electric field, Displacement density, Dipole, Potential, Work and Energy, Electric polarization, Conductors, Dielectrics, Capacitance calculation, Boundary conditions , Method of images, Poisson's and Laplace's equations - applications	Ch.3 (3.1-3.9, 3.11), Ch. 4 (4.1-4.3, 4.4.1)
14-19	Steady currents and Magnetostatics	Current density, Boundary conditions, Ohm's law, Kirchhoff's laws, Joule's law, Resistance calculation, Biot-Savart law, Magnetic vector potential, Magnetic dipole, Magnetic media, Inductance calculation	Ch. 5 (5.2-5.7), Ch. 6 (6.1-6.5, 6.7, 6.10,6.11)
20-30	Time varying (dynamic) fields	Maxwell's equations in various forms, Boundary conditions, Plane wave solutions of Maxwell's equations in free space, Wave polarization, Poynting theorem and power flow, Dispersion and group velocity, Incidence of plane wave at conducting and dielectric boundaries, Concepts of quarter wave matching and half wave window, Total internal reflection	Ch. 7 (7.3,7.5, 7.6, 7.7) Ch. 8 (8.1-8.5, 8.6, 8.8, 8.9, 8.10)
31-40	Transmission lines and antennas	Concepts of guided and unguided waves, Lumped and distributed models, Transmission line parameters, Reflection coefficient, SWR, Impedance transformation, Transmission line as circuit element, Impedance matching, Smith chart, Basics of antennas and radiation	Ch. 9 (9.1-9.4, 9.6) Ch. 11 (11.2), Lecture notes

NB: Topics from the textbook given in the lecture plan are for guidance only. The treatment and the depth of coverage of certain topics may vary slightly from what is given in the textbook (T1). Tests will be based on what is covered in the lecture and the tutorial hours.

5. Evaluation Scheme

Component	Duration	Marks (200)	Date & Time	Evaluation type
Assignments	Take home	20 (10 %)	Will be announced	Open book
Surprise quiz	15-20 min	40 (20 %)	During tutorial hours or as per announcement	Closed book
Mid sem. Exam	90 min	60 (30 %)	9/10 9:00 - 10:30 AM	Closed book
Comprehensive Exam	3 hours	80 (40 %)	5/12 FN	Open + Closed book

6. Minimum performance requirement for valid grade: Will be announced
7. Chamber Consultation Hours: Will be announced
8. Notices: Will be displayed on **EEE notice board** and **Nalanda.**
9. Absence and Makeup policy: There will be no makeup for quizzes. For other components, make-up will be granted based on genuineness of the case. If a student is likely to be absent for an evaluation, he/she **MUST** inform the IC in advance through an Email application stating the absence reason. In the case of medical leaves, proper proof must be produced if required by the IC.

(PRAVEEN KUMAR A.V.)
Instructor-in Charge
EEE/INSTR F212