GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS AND COMMUNICATION (11)
ENGINEERING ELECTROMAGNETICS
SUBJECT CODE: 2151102
B.E. 5th SEMESTER

Type of course: Electromagnetics Theory and Wave Propagation

Prerequisite: Basic knowledge of vector calculus, Electric and Magnetic fields and its laws.

Rationale: This course provides strong foundation for understanding the fundamental principles and laws of electromagnetism to understand transmission, radiation and propagation theory. Students can understand the physical interpretation and application of various laws and theorems of electric and magnetic fields. The students can also understand the transmission lines, antennas and waveguides theory.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Vector Analysis:** Scalars and Vectors, Vector Algebra, The Rectangular Coordinate System, Vector Components and Unit Vectors, The Vector Field, The Dot Product, The Cross Product, Other Coordinate Systems: Circular, Cylindrical Coordinates & The Spherical Coordinate System.	**04**	**05**
2	**Coulomb's Law and Electric Field Intensity:** The Experimental Law of Coulomb, Electric Field Intensity, Field Arising from a Continuous Volume Charge Distribution, Field of a Line Charge, Field of a Sheet of Charge, Streamlines and Sketches of Fields	**05**	**10**
3	**Electric Flux Density, Gauss's Law and Divergence:** Electric Flux Density, Gauss's Law and Application of Gauss's Law: Some Symmetrical Charge Distributions and Differential Volume Element, Divergence and Maxwell's First Equation, The Vector Operator ∇ and the Divergence Theorem.	**05**	**15**
4	**Energy and Potential:** Energy Expended in Moving a Point Charge in an Electric Field, The Line Integral, Definition of Potential Difference and Potential, The Potential Field of a Point Charge, The Potential Field of a System of Charges: Conservative Property, Potential Gradient, The Electric Dipole, Energy Density in the Electrostatic Field.	**06**	**10**

5	**Conductors and Dielectrics:** Current and Current Density, Continuity of Current, Metallic Conductors, Conductor Properties and Boundary Conditions, The Method of Images, Semiconductors, The Nature of Dielectric Materials, Boundary Conditions for Perfect Dielectric Materials.	**06**	**05**
6	**Capacitance:** Capacitance, Parallel-Plate Capacitor, Several Capacitance Examples, Capacitance of a Two-Wire Line, Using Field Sketches to Estimate Capacitance in Two-Dimensional Problems, Poisson's and Laplace's Equations, Examples of the Solution of Laplace's Equation, Example of the Solution of Poisson's Equation: the *p-n* Junction Capacitance	**06**	**05**
7	**The Steady Magnetic Field:** Bio-Savart Law, Ampere's Circuital Law, Curl, Stokes' Theorem, Magnetic Flux and Magnetic Flux Density, The Scalar and Vector Magnetic Potentials, Derivation of the Steady-Magnetic-Field Laws.	**06**	**15**
8	**Magnetic Forces, Materials and Inductance:** Force on a Moving Charge, Force on a Differential Current Element, Hall Effect, Force between Differential Current Elements, Force and Torque on a Closed Circuit, The Nature of Magnetic Materials, Magnetization and Permeability, Magnetic Boundary Conditions, The Magnetic Circuit, Potential Energy and Forces on Magnetic Materials	**06**	**10**
9	**Time-Varying Fields and Maxwell's Equations:** Faraday's Law, Displacement Current, Maxwell's Equations in Point Form, Maxwell's Equations in Integral Form, The Retarded Potentials	**06**	**10**
10	**Electromagnetic Wave Propagation:** Wave Propagation in Free Space, Lossy and Lossless Dielectrics and in Good Conductors. Reflection of Plane Wave, Poynting Vector, Wave Power, Skin Effect, Wave Polarization and Standing Wave Ratio	**06**	**15**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
05	**20**	**10**	**20**	**10**	**05**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Engineering Electromagnetics, William H Hayt And John A Buck - Tata McGraw-Hill Publishing Company Limited, Seventh Edition
2. Principles of Electromagnetics, Matthew N. O. Sadiku - Oxford university press, 2007 - fourth edition
3. Electromagnetics with applications by J.D.Krauss and Daniel Fleisch fifth edition, Mcgraw Hill.

4. Fundamentals of Electromagnetics with MATLAB, Karl Erik Lonngren, Sava Vasilev Savov, SCITECH Publishing Inc.

Course Outcome:

After learning the course the students should be able to:

1. Explain the physical interpretation of coulomb's law, Gausses law, Biot Savart law and Amperes Circuital law
2. Explain the physical interpretation and application of divergence, curl and gradient.
3. Analyze the electromagnetic waves using divergence theorem and stock theorem.
4. Design, analyze and test the capacitor, co-axial cable, waveguide and antennas.
5. Analyze the electromagnetic waves using Maxwell's equations, Poisson's and Laplace equations.
6. Determine skin effect, Hall Effect, pointing vector, and standing wave ratio of electromagnetic waves.
7. Describe and analyze electromagnetic wave propagation in free-space, dielectrics and conductors.

List of Experiments: Assignments from different chapters to be given to students. Numerical to be solved from each chapter in tutorial class.

Design based Problems (DP)/Open Ended Problem:

1. Design the MATLAB programs for vector calculus.
2. Design MATLAB programs to calculate electric field intensity due to line, surface and volume charge density.
3. Design MATLAB programs for gradient operation.
4. Design MATLAB programs for divergence operation.
5. Design MATLAB programs for curl operations.

List of Open Source Software/learning website:

1. CD available with first reference book.
2. nptel.ac.in
3. Scilab
4. http://www.Scitechpub.com/
5. wikipedia.org

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.