GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL & ELECTRONICS ENGINEERING (08) & ELECTRICAL ENGINEERING (09)

FIELD THEORY

SUBJECT CODE: 2140909

B.E. 4th SEMESTER

Type of Course: Engineering Science (Electrical)

Prerequisite: Basics of Electrical Engineering

Rationale: This course will provide strong fundamental of Electromagnetic field theory of Electrical/Electronics & Communication/Electronic Instrumentation Engineering. The students will understand the nature of electrostatic and electromagnetic fields. The students will also understand the behavior of transmission lines under steady state and transient condition essential concepts for the design and analysis of all communication and radar systems. Moreover, they will also be able to interpret electromagnetic interference in the systems for compatibility studies.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Vector Analysis** Scalars and Vectors, Vector Algebra, The rectangular co-ordinate system, Vector components and unit vectors, The vector field, The dot product, The cross product, Circular cylindrical co-ordinates, Spherical co-ordinate system.	3	9
2	**Coulomb's law and Electric Field Intensity** The experimental law of Coulomb, Electric field intensity, Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.	4	9
3	**Electric Flux Density, Gauss' law and Divergence** Electric flux density, Gauss' law, Application of Gauss' law: some symmetrical charge distributions, Application of Gauss' law to differential volume element, Divergence, Maxwell's first equation, The divergence theorem.	4	9
4	**Energy and Potential** Energy expended in moving a point charge in electric field, The line integral, Definition of potential and potential difference, The potential field of a point charge, The potential field of a system of charges, Potential gradient, The dipole, Energy density in the electrostatic field	4	9
5	**Current and Conductors** Current and current density, Continuity of current, Metallic conductors,	3	7

	Conductor properties and boundary conditions, Semiconductors.		
6	**Dielectrics and capacitance** The nature of dielectric materials, Boundary conditions for perfect dielectric materials, Capacitance, Several capacitance examples, Capacitance of a two wire line	3	7
7	**Poisson's and Laplace's Equation** Derivation of Poisson's and Lapalce's equations, Uniqueness theorem, Example of the solution of Laplace's equation Example of solution of Poisson's equation	3	8
8	**The Steady Magnetic Field** Biot Savart law, Ampere's circuital law, Curl, Stoke's theorem, Magnetic flux and magnetic flux density, The scalar and vector magnetic potentials, Derivation of steady magnetic field laws.	4	10
9	**Magnetic Forces, Materials and Inductance** Force on a moving charge, Force on a differential current element, 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, Inductance and mutual inductance	4	9
10	**Time Varying Fields and Maxwell's equation** Faraday's Law, Displacement current, Maxwell's equation in point form, Maxwell's equation in integral form,	3	7
11	**Transmission Lines** Physical description of transmission line propagation, The transmission line equation, Lossless propagation, Lossless propagation of sinusoidal voltages, Complex analysis of sinusoidal voltages, Transmission line equations and their solutions in phasor form	4	8
12	**Effects of Electromagnetic Fields** Electromagnetic Interference and Compatibility (EMI/EMC), EMI Sources, Effects of EMI, Methods to eliminate EMI, EMC Standards, Advantages of EMC standards, Biological effects of EMI/EMR (Electromagnetic Interference, Electromagnetic radiation)	3	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
20	15	15	10	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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 by W.H. Hayt and J A Buck, Tata McGraw Hill Publications
2. Electromagnetic Field Theory and Transmission Lines by G.S.N. Raju, Pearson Education
3. Fundamentals of Electromagnetics by A.V. Mahatme, University Science Press
4. Elements of Electromagnetics by Matthew N.O. Sadiku, Oxford University Press
5. Electromagnetics with Applications by Kraus and Fleisch, Tata McGraw Hill Publications
6. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan, Oxford University Press

Suggested Resource Material for tutorials based on above topics

- Numericals based on solving Engg. Electromagnetics problems using MATLAB for tutorials are available in CD accompanied with the book of "Fundamentals of Engineering Electromagnetics by Sunil Bhooshan"
- Matlab Experiments manual for Electromagnetics by Dr. M.H. Bakr

Course outcome: After the completion of this course the student will have understanding of electrostatic and magnetostatic fields which in future will help to understand its applications in Electrostatic generators, Electric power transmission, Lighting protection, Electro deposition, Magnetic separators, Development of motors, Transformers, Electromagnetic pump and so on

Active Learning Assignments (ALA) : Preparation of power-point slides: which may include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus can 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 faculty and the department.