GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3140912
Semester-IV
Subject Name: Electromagnetic Fields

Type of course: Basic Science Course

Prerequisite: NA

Rationale: Study of electromagnetic fields is basically concerned with study of charges at rest and in motion. Electromagnetic principles serve as basic fundamentals for detailed and in-depth study of electrical engineering and are indispensable for analysis of various electrical, electro-mechanical and electronic systems. This subject would cover the behavior of static and dynamic, electric and magnetic fields.

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)	
3	1	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Review of Vector Analysis** Introduction, scalars and vectors, unit vector, vector addition and subtraction, position and distance vectors, dot product, cross product, scalar triple product, vector triple product, components of a vector, Cartesian co-ordinate system, Circular cylindrical co-ordinate system, Spherical co-ordinate system, transformation from one co-ordinate to other co-ordinate systems	**04**
2	**Static Electric Fields** Coulomb's law, Electric field intensity, Electric field due to point and line charges, Line surface and volume charge distributions, Gauss' law and its applications, Divergence theorem, Absolute Electric potential, Potential difference, Potential gradient, Calculation of potential difference for different configurations, Electric dipole, Electrostatic energy and energy density	**08**
3	**Conductors, Dielectrics and Capacitance** Current and current density, Ohm's law in point form, Continuity equation, Conductor-dielectric boundary condition, Dielectric-dielectric boundary condition, Polarization in dielectrics, Capacitance, Capacitance of two wire line	**06**
4	**Poisson's and Laplace's equations** Poisson's equation, Laplace's equation, Uniqueness theorem, Solution of Poisson's and Laplace's equation, Application of Poisson's and Laplace's equations	**04**
5	**Steady Magnetic Fields** Biot Savart's law, Ampere's law, Curl operation, Stoke's theorem, Magnetic flux and magnetic flux density, Scalar and vector magnetic potentials, Steady magnetic field produced by current carrying conductors	**08**

6	**Magnetic forces, materials and inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and Permeability, Magnetic boundary conditions, Magnetic circuit, Inductance and mutual inductances	**06**
7	**Time varying fields and Maxwell's equations** Faraday's law, Transformer and motional electromotive forces, Displacement current, Maxwell's equations in integral and point form, Time varying potentials	**06**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**20**	**10**	**10**	**00**

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. W. H. Hayt, J. A. Buck, "Engineering Electromagnetics", McGraw Hill Education
2. M.N.O. Sadiku, S.V. Kulkarni, "Principles of Electromagnetics", 6th edition, Oxford University Press
3. A Pramanik, "Electromagnetism- Theory and Applications" PHI Learning Pvt. Ltd. ,New Delhi, 2009
4. A. Pramanik, "Electromagnetism-Problems with Solutions, PHI, 2012
5. S.P. Seth, "Elements of Electromagnetic fields", Dhanpat Rai & Co, 2013

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Apply vector calculus to electric and potential fields due to various charge distributions	30
CO-2	Compute potential, Electric fields, Electric flux density, Capacitance using Poisson's and Laplace's equations	25
CO-3	Derive forces and torques in magnetic fields, forces due to current carrying conductors and their inter-relationship with magnetic field	35
CO-4	Analyze Maxwell's equations in different forms (point & integral) and	10

	apply them to diverse engineering problems	

Suggested Resource Material for Assignments/Tutorials/Experiments

Suggested learning material and Assignments/Tutorials are available on the following links:

- https://nptel.ac.in/downloads/108104087/ by Prof. Pradeep Kumar, IIT, Kanpur
- https://nptel.ac.in/downloads/115101005/ by Prof. D.K. Ghosh, IIT , Bombay
- https://nptel.ac.in/downloads/115104088/ by Prof. Manoj K. Harbola, IIT, Kanpur
- Transcripts and video lectures of Prof. Harishankar Ramachandran, IIT, Madras https://nptel.ac.in/courses/108106073/
- Matlab experiments manual by Dr. M. H. Bakr http://www.ece.mcmaster.ca/faculty/talia/EM_2FH3_downloads/assignments/Matlab_Manual_2FH3_Bakr.pdf