



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000301

Subject Name : Electromagnetics

WEF Academic Year :	2024-25
Semester :	4
Category of the Course :	Basic Science Course

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.

## Course Outcome:

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Show physical interpretation of gradient, divergence and curl.	UN ,RM
02	Analyze the electromagnetic waves using divergence theorem and stock theorem.	AN
03	Design and measure the field in capacitor and co-axial cable	AP,AN,EL
04	Compare skin effect and hall effect	EL ,AN
05	Analyze electromagnetic wave in free space and in dielectrics	AN

\*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

## Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	30	0	15	90	3	70	30	20	30	50	200

\* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.



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## Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	<b>Vector Analysis:</b> 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 Coordinate System, Spherical Coordinate System, Del Operator, Divergence, Gradient, Curl and Laplacian.	5	5
2	<b>Coulomb's Law and Electric Field Intensity:</b> 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	4	10
3	<b>Electric Flux Density, Gauss's Law and Divergence:</b> 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 $\nabla$ and the Divergence Theorem.	4	15
4	<b>Energy and Potential:</b> 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.	4	10
5	<b>Conductors and Dielectrics:</b> 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.	4	5
6	<b>Capacitance:</b> 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 <i>p-n</i> Junction Capacitance	4	5



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7	<b>The Steady Magnetic Field:</b> 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.	4	15
8	<b>Magnetic Forces, Materials and Inductance:</b> 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	4	10
9	<b>Time-Varying Fields and Maxwell's Equations:</b> Faraday's Law, Displacement Current, Maxwell's Equations in Point Form, Maxwell's Equations in Integral Form, The Retarded Potentials	4	10
10	<b>Electromagnetic Wave Propagation:</b> 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	5	15

## Reference Book :

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

**Suggested Course Practical List:** Assignments from different chapters to be given to students. Numerical to be solved from each chapter in tutorial class.

**List of Laboratory/Learning Resources Required:** nptel.ac.in

### • Activities suggested under Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and



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			calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health /any other issue	Duration = 15 h for industrial exposure  Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending	Duration = 1 h each	Based on performance in group discussion,



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	technical topics based on subject		technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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