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DHANALAKSHMI SRINIVASAN
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COURSE PLAN

Subject code: EC8451	**Branch/Year/Sem/Section: B.E ECE/II/IV**
Subject Name: ELECTROMAGNETIC FIELDS	**Batch: 2018 - 2022**
Staff Name: G.EZHILARASAN (AP/EEE)	**Academic year:2019-2020**

COURSE OBJECTIVE:

To impart knowledge on the following Topics

1. To gain conceptual and basic mathematical understanding of electric and magnetic fields in free space and in materials
2. To understand the coupling between electric and magnetic fields through Faraday's law, displacement current and Maxwell's equations
3. To understand wave propagation in lossless and in lossy media
4. To be able to solve problems based on the above concepts

TEXT BOOK:

T1. D.K. Cheng, Field and wave electromagnetics, 2nd ed., Pearson (India), 1989 (UNIT I, II,III IV,V)
T2.W.H.Hayt and J.A. Buck, Engineering electrmagnetics, 7th ed., McGraw-Hill (India), 2006(UNIT I-V)

REFERENCES:

R1. R. D.J. Griffiths, Introduction to electrodynamics, 4th ed., Pearson (India), 2013
R2. B.M. Notaros, Electromagnetics, Pearson: New Jersey, 2011
R3. M.N.O. Sadiku and S.V. Kulkarni, Principles of electromagnetics, 6th ed., Oxford (Asian Edition), 2015

ADDITIONAL REFERENCES:

AR1. E.C. Jordan & K.G.Balmain Electromagnetic Waves and Radiating Systems", Pearson Education/PHI 4th edition 2006
AR2. G.S.N.Raju, Electromagnetic Field Theory &Transmission Lines, Pearson Edition, 2006

TEACHING METHODOLOGIES:

- BB - BLACK BOARD
- VIDEO - VIDEO TUTORIAL
- PPT - POWER POINT PRESENTATION

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SYLLABUS

EC8451	ELECTROMAGNETIC FIELDS	L P T C
		4 0 0 4

UNIT I INTRODUCTION 12

Electromagnetic model, Units and constants, Review of vector algebra, Rectangular, cylindrical and spherical field, Divergence theorem, Curl of vector field, Stoke's theorem, Null identities, Helmholtz's theorem coordinate systems, Line, surface & volume integrals, Gradient of scalar field, Divergence of vector

UNIT II ELECTROSTATICS 12

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Capacitance, Parallel, cylindrical and spherical capacitors, Electrostatic energy, Poisson's and Laplace's equations, Uniqueness of electrostatic solutions, Current density and Ohm's law, Electromotive force and Kirchhoff's voltage law, Equation of continuity and Kirchhoff's current law

UNIT III MAGNETOSTATICS 12

Lorentz force equation, Law of no magnetic monopoles, Ampere's law, Vector magnetic potential, Biot- Savart law and applications, Magnetic field intensity and idea of relative permeability, Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torques

UNIT IV TIME VARYING FIELDS AND MAXWELL'S EQUATIONS 12

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields

UNIT V PLANE ELECTROMAGNETIC WAVES 12

Plane waves in lossless media, Plane waves in lossy media (low-loss dielectrics and good conductors), Group velocity, Electromagnetic power flow and Poynting vector, Normal incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary

TOTAL : 60 PERIODS

Topic No.	Topic Name	Books for reference	Page No	Teaching Methodology	No of periods required	Cumulative No. of periods
UNIT I	**INTRODUCTION**				**(12)**	
1.	**Introduction** ▪ Electromagnetic model, ▪ Units and constants	T1	19-24	Black Board	1	1
2.	**Introduction to Vectors** **Vector Algebra** ▪ Vector Additional and Subtraction ▪ Multiplication of a Scalar and a Vector ▪ Properties of vectors.	T1 T2 AR1	24-26 2-4 2-9	Black Board	1	2
3.	**Vector Calculus** ▪ Gradient ▪ Divergence ▪ Curl of vector	T1 AR1	27-28 10-13	Black Board	1	3
4.	**Introduction to Co-ordinate System** ▪ Rectangular or Cartesian Co-ordinate System	T1 T2 AR1	36-40 4-5 13-15	Video Tutorial	1	4
5.	Cylindrical co-ordinate system	T1 T2	41-46 14-19	Video Tutorial	1	5
6.	Spherical co-ordinate system	T1 T2	47-53 19-22	Video Tutorial	1	6
7.	Introduction to line, surface and volume integrals	T1	53-58	Black Board	1	7
8.	**Divergence theorem** ▪ Statement and mathematical expression	T1 T2	66-70 82-85	Black Board	1	8
9.	**Stokes theorem** ▪ Statement and mathematical expression	T1	70-77	Black Board	1	9
10.	Null identities,	T1	77-79	Black Board		10
11.	Helmholtz's theorem	T1	79-81	Black Board		11
12.	Problems related to Co-ordinate systems	T1	40-61	Black Board		12

LEARNING OUTCOME

At the end of the unit, students should be able to

- Analyze the things in Three dimensional view and direction of field.

UNIT II ELECTROSTATICS						(12)
13.	**Introduction to Electric field, Coulomb's law** ▪ Statement ▪ Vector form of coulomb's law	T1 T2 AR2	88-103 27-43 82-92	Black Board	1	13
14.	**Gauss law** ▪ Statement & Proof of Gauss law ▪ Applications ▪ Gauss divergence theorem	T1 T2	103-108 55-64	Black Board	1	14
15.	**Absolute Electric scalar potential and potential difference** ▪ Relationship between potential and electric field ▪ Potential due to infinite uniformly charged line	T1 T2 AR2 AR1	108-116 87-101 107-113 30-35	Black Board	1	15
16.	**Conductors and dielectric field** ▪ Current & Current density	T1 T2	116-121 112-114	Black Board	1	16
17.	**Electric flux density and dielectric constant** ▪ Statement & Expression	T1 T2	125-132 13-143	Black Board	1	17
18.	**Boundary conditions** ▪ Boundary conditions between conductor and free space ▪ Normal component and Tangential component of a Boundary	T1 T2	132-137 143-148	Black Board	1	18
19.	**Capacitance** ▪ Definition of Capacitance ▪ Calculation of Capacitance of parallel plate	T1	137-140	PPT	1	19
20.	▪ Calculation of Capacitance of coaxial cable ▪ Calculation of Capacitance of spherical capacitance	T1 T2	140-149 149-159	Black Board	1	20
21.	Electrostatic energy	T1	149-159	Black Board	1	21
22.	**Poisson's and Laplace's Equation** ▪ Definition and expression ▪ Uniqueness of electrostatic solutions, Current density and Ohm's law	T1 T2	168-221 177-188	Black Board	1	22

23.	▪ Electromotive force and Kirchhoff's voltage law ▪ Equation of continuity and Kirchhoff's current law	T1 T2	221-226 116-118	Black Board	1	23
24.	Problems Related to capacitance	T1	137-149	Black Board	1	24
LEARNING OUTCOME At the end of the unit, students should be able to • Analyze the electrostatic field conditions in Free space and conducting media.						
UNIT III MAGNETOSTATICS					**(12)**	
25.	**<u>Introduction</u>** ▪ Lorentz force equation ▪ Law of no magnetic monopoles ▪ Ampere's law – statement & Proof	T1 T2	241-243 260-265	Black Board	1	25
26.	**<u>Vector Magnetic potential</u>** ▪ Magnetic moment ▪ Magnetic scalar potential ▪ Magnetic vector potential	T1 T2	248-250 240-290	Black Board	1	26
27.	**<u>Biot-Savart Law</u>** ▪ Statement and Applications ▪ Magnetic field intensity due to Finite Length of Conductors carrying current I ▪ Magnetic field intensity due to infinite length of conductor carrying a current I	T1 T2 AR2 AR1	250-255 210-121 185-189 90-92	Black Board	1	27
28.	▪ Magnetic field intensity on the axis of a circular loop carrying current 'I' ▪ Magnetic field intensity on the axis of a rectangular loop carrying current	T1 T2 AR2 AR1	250-255 210-121 185-189 90-92	Video Tutorial	1	28
29.	**<u>Magnetic flux and flux density & relative permeability</u>** ▪ Definition ▪ Magnetic flux or Gauss law in integral form, differential form ▪ Relative permeability – definition & expression	T1 T2	256-263 212-214	Black Board	1	29

30.	**Magnetic circuit** ▪ Expression ▪ Potential energy and force on magnetic materials **Nature of the magnetic materials** ▪ Types of magnetic materials ▪ Behavior of magnetic material	T1 T2	267-276 284-290	Black Board	1	30
31.	**Magnetic boundary conditions** ▪ Tangential component ▪ Normal component	T1 T2	278-282 281-284	Black Board	1	31
32.	**Inductance** ▪ Definition and basic expression ▪ Self and mutual inductance ▪ Inductance evaluation for toroid	T1 T2	282-286 291-299	PPT	1	32
33.	▪ Inductance evaluation for solenoid ▪ Inductance evaluation for coaxial cable ▪ Inductance evaluation for transmission line	T1 T2	286-292 291-299	Black Board	1	33
34.	**Magnetic Energy** ▪ Energy stored in magnetic field	T1 T2	293-297 290-292	Black Board	1	34
35.	**Magnetic Force** ▪ Force on a moving charge, differential element ▪ Force between current elements **Magnetic Torque** ▪ Torque on closed circuit	T1 T2 AR2	297-310 260-273 200-211	Black Board	1	35
36.	Problems related to Magnetic Field Intensity and Inductance	T1	250-310	Black Board	1	36
LEARNING OUTCOME At the end of the unit, students should be able to • Analyze the Magneto-static field conditions in Free space and conducting media. • To know the design details of the coil based on the application.						
UNIT IV TIME VARYING FIELDS AND MAXWELL'S EQUATIONS (12)						
37.	**Introduction** ▪ Faraday's law for electromagnetic induction	T1 T2 AR1	323-326 306-308 720-723	Black Board	1	37

38.	**Transformers equation** ▪ Expression for transformer induced EMF equation	T1 T2 AR1	327-330 308-313 720-723	Video Tutorial	1	38
39.	**Motional EMF equation** ▪ Expression for motional electromotive force equation	T1 T2 AR1	327-330 308-313 720-723	Black Board	1	39
40.	**Displacement Current** ▪ Statement & Expression **Maxwell –Ampere law** ▪ Statement & Expression	T1 T2	330-337 317-321	Black Board	1	40
41.	**Maxwell's equations** ▪ Differential form of Maxwell's equations	T1 AR1	337-342 203-204	Black Board	1	41
42.	**Maxwell's equations** ▪ Integral form of Maxwell's equations	T1 AR1	337-342 203-204	Black Board	1	42
43.	**Potential functions** ▪ Time varying potentials	T1 T2	342-345 321-325	Black Board	1	43
44.	Electromagnetic boundary conditions	T1	345-348	Black Board	1	44
45.	**Wave equation** ▪ Derivation of wave equation.	T1 T2 AR2	348-350 410-417 285-288	Black Board	1	45
46.	**Wave equation** Solutions	T1 T2	348-350 410-417	Black Board	1	46
47.	**Wave equation in phasor form** ▪ Determination of α, β & η. ▪ Maxwell's Equations in phasor form.	T1 T2 AR2	348-350 417-423 294-295	Black Board	1	47
48.	**Time harmonic fields** ▪ Point form of Ampere's circuital law ▪ Point form of Gauss law	T1 T2	351-362 389-400	Black Board	1	48

LEARNING OUTCOME

At the end of the unit, students should be able to

- Apply this concept for the propagation of Electromagnetic waves.
- Know the differential and integral form of Waves by Maxwell equations.

UNIT V PLANE ELECTROMAGNETIC WAVES (12)

49.	**Uniform plane waves** ▪ Introduction and its Properties ▪ Uniform plane wave in perfect dielectric.	T1 T2 AR1	371-378 396-398 116-130	Black Board	1	49
50.	▪ Uniform plane wave in lossy dielectric.	T1 T2	378-380 398-403	Black Board	1	50

51.	▪ Uniform plane wave in practical dielectric.	T1 T2	380-391 404-410	Black Board	1	51
52.	**Group velocity** ▪ Statement and Expression		391-395	Black Board	1	52
53.	Poynting vector	T1 T2	395-398 435-436	Black Board	1	53
54.	Poynting theorem	T1 T2 AR1	398-400 436-438 162-173	Black Board	1	54
55.	**Electromagnetic power flow** ▪ Average power density	T1 T2	400-402 438-440	Black Board	1	55
56.	Poynting theorem and Power flow problems	T1	395-402	Black Board	1	56
57.	**Normal incidence at a plane conducting boundary** ▪ Description ▪ Derivation	T1 T2	402-406 450-455	Black Board	1	57
58.	**Normal incidence at a plane dielectric boundary** ▪ Description ▪ Derivation	T1 T2	413-417 456-462	Black Board	1	58
59.	Problems based on Uniform Plane waves(Lossy and Perfect dielectric)	T1	371-395	Black Board	1	59
60.	Problems based on Uniform Plane waves(Practical dielectric)	T1	371-395	Black Board	1	60

LEARNING OUTCOME

At the end of the unit, students should be able to

- Understand the propagation of Uniform plane waves.
- Calculate the Electromagnetic power flow constants by using Poynting theorem.

COURSE OUTCOME

At the end of the course, the student should be able to:

- ❖ Display an understanding of fundamental electromagnetic laws and concepts
- ❖ Write Maxwell's equations in integral, differential and phasor forms and explain their physical meaning
- ❖ Explain electromagnetic wave propagation in lossy and in lossless media
- ❖ Solve simple problems requiring estimation of electric and magnetic field quantities based on these concepts and laws

CONTENT BEYOND THE SYLLABUS

- ❖ Polarization
- ❖ Reluctance

CONTINUES INTERNAL ASSESSMENT DETAILS

ASSESMENT NUMBER	I	II	MODEL
TOPIC NO.(UNIT)	1-18 (1st & 2nd units)	19-36 (3rd & 4th units)	1-45 (units 1-5)

ASSIGNMENT DETAILS

ASSIGNMENT NUMBER	I	II	III
TOPIC NUMBER FOR REFERENCE	1-18 (1st & 2nd units)	19-36 (3rd & 4th units)	1-45 (units 1-5)
DEAD LINE			

ASSIGNMENT NUMBER	BATCH	DESCRIPTIVE QUESTIONS/TOPIC (Minimum of 8 Pages)
I	B1	1. Spherical coordinate system 2. Divergence Theorem 3. Gauss Law and its application
II	B1	1. Maxwell's equations are derived from different basic laws 2. Electromagnetic Wave equations
III	B1	1. Biot-Savart Law and its applications. 2. Uniform plane wave in Lossy dielectric 3. Poynting Theorem

PREPARED BY **VERIFIED BY** **APPROVED BY**

G.EZHILARASAN, AP/EEE **HOD** **PRINCIPAL**