INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**ELECTRO MAGNETIC FIELD**				
Course Code	AEEB10				
Programme	B.Tech				
Semester	THREE				
Course Type	Professional Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. T Anil Kumar, Assistant Professor				

I. COURSE OVERVIEW:

Electromagnetic theory field deals with vector algebra, principles and basic laws of electrostatics, characteristics and properties of conductors and dielectrics, behavior of static magnetic field and application of ampere law, determination of force in magnetic field and magnetic potential, concept of time varying fields and propagation of electro-magnetic waves.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AHSB02	I	Linear Algebra Calculus
UG	AHSB04	II	Waves And Optics

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Electromagnetic Field Theory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria in Table 1:

Table 1: The Expected Percentage Of Cognitive Level Of Questions In SEE

Percentage Of Cognitive Level	Blooms Taxonomy Level
10 %	Remember
50%	Understand
40%	Apply
0%	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 2: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz –Online Examination:

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT):

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

The AAT chosen for this course is given in table 3.

Table 3: Assessment Pattern for ATT

5 Minutes Video	Assignment	Tech Talk	Seminar	Open Ended Experiment
25%	25%	25%	25%	0%

VI. COURSE OBJECTIVES:

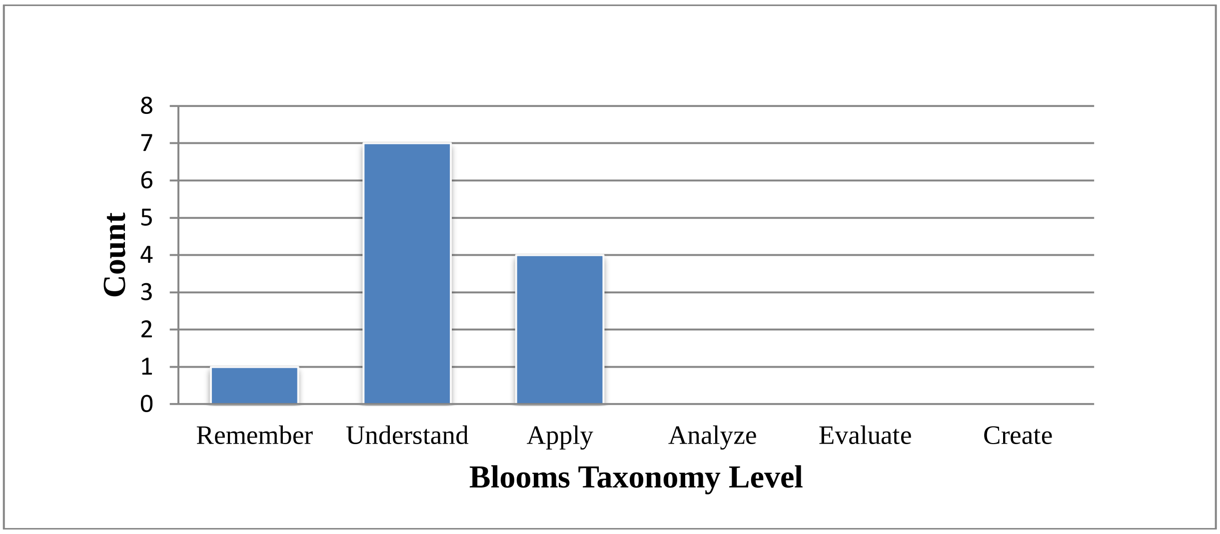
The students will try to learn:	
I	*The concepts of electro-statics , magneto-statics and time varying fields that allows required foundations in structure of power generation, transmission and distribution systems.*
II	*The nature of wave propagation in free space, conductors and dielectrics to frame multi-disciplinary assignments with real time constraints.*
III	*The fundamentals of electromagnetic fields and wave propagation to figure out the complex engineering problems with solutions and also helps in pursuing higher studies.*

VII. COURSE OUTCOMES:

After successful completion of the course, Students will be able to:

CO No	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO 1	Make use of coloumb's law for obtaining force and electric filed intensity due to line, surface and volume charge distribution.	Apply
CO 2	Recognize the basic nomenclatures of point charge that helps in characterizing the behavior of electro-static fields .	Understand
CO 3	Make use of the Gauss law for obtaining electric field intensity, density and deduce Poisson's, Laplace equations.	Apply
CO 4	Determine the potential and torque due to electric dipole used in structuring the principle of electrical equipments.	Understand
CO 5	Realize the behavior of conductors and dielectrics, their by compute the capacitance of different configured plates.	Understand
CO 6	Make use of Biot-Savart law and Ampere circuital law for obtaining magnetic field intensity due to circular, square, rectangular and solenoid current carrying wire.	Apply
CO 7	Predict the force due to moving charge in the magnetic field of various configuration for developing principles of electrical machines.	Understand

CO 8	Signify the magnetic dipole , dipole moment for obtaining torque due to magnetic dipole helps in structuring electrical devices..	Understand
CO 9	Calculate the self inductance and mutual inductance for different configurations of wires and energy stored in the coil.	Understand
CO 10	State the Faraday's laws of electromagnetic induction and note the nature of emf induced in the coil for fixed and variable fields.	Remember
CO 11	List out the differential and integral forms of Maxwell's equation in time varying fields and fields varying harmonically with time for obtaining numerical solutions of complex engineering problems.	Understand
CO 12	Make use of the Maxwell Equations to produce a wave equation for the free-space, insulators and conductors for propagation of electromagnetic waves.	Apply



VIII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

IX. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency assessed by
PSO1	Analyse. Design, investigate, simulate and/or fabricate/commission the electrical system involving generation, transmission, distribution and utilization of electrical energy.	2	Research Paper / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

X. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 2	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	√	-	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 4	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 5	√	√	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 6	√	√	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 7	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 8	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 9	√	√	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 10	√	-	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 11	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-

XI. JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING

Course Outcomes	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	Recollect the basics of matter , types of charge distribution and vector analysis for solving the force and electric field intensity using the **knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 2	Determine the standard expressions for electric filed intensity due to line, surface and volume charge distributions to **analyze complex engineering problems using principles of mathematics and engineering sciences**.	7
	PSO 1	Make use of coloumbs law in structuring the principles of electrostatic instruments using in **power system for generation and measurement**.	1
CO 2	PO 1	Understand the characteristics of point charge in terms of its basic definitions in order to determine the **same using principles of mathematics, science, and engineering fundamentals.**	3
CO 3	PO 1	Explain how one can say that net charge enCOsed in the given area is zero with the help of **basic fundamentals of science, and engineering fundamentals.**	3
	PO 3	**Design the solution for problems** where the behavior of material can be understood for implementation in power system.	5

	PSO 1	Make use of Gauss law for understanding material behavior in **different stage of power system.**	1
CO 4	**PO 1**	Determine characteristics of electric dipole which helps in structuring the principles of electrical machines and equipment with the **fundamentals of mathematics, science, and engineering fundamentals.**	3
	PO 2	Derive the standard expression for potential and torque due to electric dipole using which principles of electrical devices can be **framed using basics of mathematics and engineering sciences.**	6
	PSO 1	Understand the importance of electric dipole and its properties in **lay down of power system.**	1
CO 5	**PO 1**	Understand the behavior of conductors and dielectrics with the **knowledge of mathematics, science and engineering fundamentals for capacitance calculation.**	3
	PO 2	Derive the standard expression for different configured capacitors to analyse complex engineering problems **using basic mathematics and engineering principles.**	7
	PO 3	Determine capacitance of power system equipments to design electrical components at **different stages to meet the required specifications.**	4
	PSO 1	Recognize the importance of conductors and dielectrics in the **generation, transmission and distribution of power.**	1
CO 6	**PO 1**	**Use the basics of mathematics, science and engineering fundamentals** for obtaining magnetic field intensity and magnetic flux density.	3
	PO 2	Determine standard expressions of magnetic field intensity and density with helps **in solving complex engineering problems.**	7
	PO 3	Design the characteristics of magnetic field using bio savart and ampere laws which helps in **obtaining the desired specifications of electrical components.**	5
	PSO 1	Understand the characteristics of magnetic field the structure **principles of electrical equipments in power systems.**	1
CO 7	**PO 1**	Understand type of force due to different configured conductors with the help of **basic fundamentals of mathematics science and engineering fundamentals.**	3
	PO 2	Determine standard expressions of force on the various shaped conductors placed in magnetic field for **analyzing behavior of complex electrical devices.**	7
	PSO 1	Design the type and nature of forces from magnetic fields **to frame the principles of power system equipment.**	1
CO 8	**PO 1**	Explain characteristics of magnetic dipole which helps in structuring the principles of electrical machines and equipment with the **fundamentals of mathematics, science, and engineering fundamentals.**	3
	PO 2	Obtain the standard expression for potential and torque due to magnetic dipole using which principles of electrical devices can be **framed using basics of mathematics and engineering sciences.**	6
	PSO 1	Understand the importance of magnetic dipole and its properties in **lay down of power system.**	1

CO 9	**PO 1**	Calculate the self and mutual inductance of various configured coils **using the principles of mathematics and engineering fundamentals.**	3
	PO 2	Develop the standard expressions of self and mutual inductance for different shaped coils **using which complex engineering problems can be solved with help of basic mathematics and engineering sciences.**	6
	PO 3	Solve the self and mutual inductance of complex engineering problems to **obtain the desired specifications of electrical component in power system.**	5
	PSO 1	Summarize the features of coils their by constructing the various types of windings in for **required output from electrical machines in power system.**	1
CO 10	**PO 1**	Identify the nature of emf induced in the coil for fixed and variable magnetic field by applying basic knowledge of science and engineering fundamentals.	3
	PO 3	Illustrate the expressions for dynamic and statically induced emf their by designing **voltage rating of electrical machines and components can be specified.**	5
	PSO 1	Build the electrical machinery and components based on **Faraday's law of electromagnetic induction at different modes of power system.**	1
CO 11	**PO 1**	Make use of expressions obtained during analysis of electrostatics and magneto statics fields their deducing the same for time varying fields **using knowledge of mathematics , science and engineering fundamentals.**	3
	PO 2	Interpret the solution of complex problems on time varying fields and obtain some standard conclusion on properties of time varying fields **using basic principles of mathematics and engineering sciences.**	7
CO 12	**PO 1**	Demonstrate the propagation of electromagnetic wave in free space, dielectrics and conductor **using knowledge of mathematics , science and engineering fundamentals.**	3
	PO 2	Obtain the standard expressions for electromagnetic wave propagation in free space, insulators and conductors **to conclude solution of complex engineering problems using basic mathematics and engineering sciences.**	7

XII. NUMBER OF KEY COMPETENCIES FOR CO – (PO,PSO) MAPPING:

Course Outcomes	Program Outcomes / Number of Vital Features												PSOs/ No. of Vital Features		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**2**	**2**
CO 1	3	7											1		
CO 2	3														
CO 3	3		5										1		

CO 4	3	6											1		
CO 5	3	7	4										1		
CO 6	3	7	5										1		
CO 7	3	7											1		
CO 8	3	6											1		
CO 9	3	6	5										1		
CO 10	3		5										1		
CO 11	3	7													
CO 12	3	7													

XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO,PSO) MAPING:

Course Outcomes	**Program Outcomes / Number of Vital Features**												**PSOs / No. of Vital Features**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**12**	**2**	**2**	**2**
CO 1	100.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 3	100.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 4	100.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 5	100.0	70.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 6	100.0	70.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 7	100.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 8	100.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 9	100.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 10	100.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0
CO 11	100.0	70.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 12	100.0	70.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

XIV. COURSE ARTICULATION MATRIX (CO - PO / PSO MAPPING):

COs and POs and COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 – $\mathbf{0} \leq \boldsymbol{C} \leq 5\%$ – No correlation;
1 – $5 < \boldsymbol{C} \leq 40\%$– Low / Slight;

2 − $40\ \% < \boldsymbol{C} < 60\%$ – Moderate.
3 – $60\% \leq \boldsymbol{C} < 100\%$ – Substantial / High

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 7	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 8	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 9	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 10	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 11	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	36	27	10										24		
AVERAGE	**3.0**	**3.0**	**2.0**										**2.0**		

XV. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1,PO 2, PO 3	SEE Exams	PO 1,PO 2, PO 3	Assignments	PO 1,PO 2, PO 3	Seminars	PO 1,PO 2, PO 3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XVI. ASSESSMENT METHODOLOGIES – INDIRECT

\✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XVII. SYLLABUS

MODULE - I	ELECTROSTATICS
Introduction to Cartesian, cylindrical and spherical co-ordinates. Conversion of one type of co-ordinates to another; Electrostatic fields: Coulomb's law, electric field intensity due to line and surface charges, work done in moving a point charge in an electrostatic field, electric potential, properties of potential function, potential gradient, Gauss's law, application of Gauss's law, Maxwell's first law, Laplace's and Poisson's equations, solution of Laplace's equation in one variable.	
MODULE - II	**CONDUCTORS AND DIELECTRICS**
Dipole moment, potential and electric field intensity due to an electric dipole, torque on an electric dipole in an electric field, behavior of conductors in an electric field, electric field inside a dielectric material, polarization, conductor and dielectric, dielectric boundary conditions, capacitance of parallel plate and spherical and coaxial capacitors with composite dielectrics, energy stored and energy density in a static electric field, current density, conduction and convection current densities, Ohm's law in point form, equation of continuity.	
MODULE - III	**MAGNETOSTATICS**
Biot-Savart's law, magnetic field intensity, magnetic field intensity due to a straight current carrying filament, magnetic field intensity due to circular, square and solenoid current carrying wire, relation between magnetic flux, magnetic flux density and magnetic field intensity, Maxwell's second equation, div(B)=0. Magnetic field intensity due to an infinite sheet of current and a long current carrying filament, point form of Ampere's circuital law, Maxwell's third equation, Curl (H)=Jc, field due to a circular loop, rectangular and square loops.	
MODULE - IV	**FORCE IN MAGNETIC FIELD AND MAGNETIC POTENTIAL**
Moving charges in a magnetic field, Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors, magnetic dipole and dipole moment, a differential current loop as a magnetic dipole, torque on a current loop placed in a magnetic field; Vector magnetic potential and its properties, vector magnetic potential due to simple configurations, Poisson's equations, self and mutual inductance, Neumann's formula, determination of self-inductance of a solenoid, toroid and determination of mutual inductance between a straight long wire and a square loop of wire in the same plane, energy stored and density in a magnetic field, characteristics and applications of permanent magnets.	
MODULE - V	**TIME VARYING FIELDS AND FINITE ELEMENT METHOD**
Faraday's laws of electromagnetic induction, integral and point forms, Maxwell's fourth equation, curl (E)=∂B/∂t, statically and dynamically induced EMFs, modification of Maxwell's equations for time varying fields, displacement current. Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in loss dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.	
Text Books:	
1 K.B. Madhu Sahu, " Eelectromagnetic Fields", Scitech Ltd., 2^{nd} Edition.	

2	David J Griffiths, "Introduction to Electrodynamics" Pearson Education Ltd., 4th Edition, 2014.
3	Sunil Bhooshan, "Fundamentals of Engineering Electromagnetics", Oxford University Press, 1st Edition, 2012.
4	E Kuffel, W S Zaengl, J Kuffel, "High Voltage Engineering Fundamentals", Newnes, 2nd Edition, 2000.

Reference Books:

1. Matthew N O Sadiku, S V Kulkarni, "Principles of Electromagnetics", Oxford University Press,6th Edition, 2015.
2. AS Mahajan , AA Rangwala "Electricity And Magnetism", McGraw Hill Publications, 1st Edition, 2000.
3. MS Naidu, V Kamaraju "High Voltage Engineering", McGraw Hill Publications, 3rd Edition, 2013.
4. William H Hayt, John A Buck, "Problems and Solutions in Electromagnetics", McGraw Hill Publications, 1st Edition, 2010.

XVIII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	CO	Reference
1	Introduction to vector algebra.	CO 1	T1: 1.1-1.3 R4:1.1-1.8
2	Analysis if different types of co-ordinates.	CO 1	T1: 1.12 R4:1.1-1.8
3	Conversion of different types of co-ordinates.	CO 1	T1: 1.12 R4:1.1-1.8
4	Introduction to electro static fields and coulomb's law.	CO 1	T1: 2.1-2.3 R2:2.3
5	Calculation Of Electric field intensity due to line and surface charges.	CO 1, CO 2	T1:2.4-2.5 R2:3.2
6	Derive the work done in moving a point charge in an electrostatic field.	CO 1, CO 2	T1:2.15 R2:2.9
7-9	Define electric potential, properties of potential function, potential gradient.	CO 2	T1:2.16-2.17 R2:2.9-2.10
10	State Gauss's law and application of Gauss's law.	CO 3	T1:2.13-2.14 R2:2.11
11	Deduce Maxwell's first law.	CO 3	T1:2.20 R2:2.11
12	Derive the Laplace's and Poisson's equations.	CO 3	T1:2.21 R2:3.5
13	Determine the solution of Laplace's equation in one variable.	CO 3	T1:2.21 R2:3.5
14	Introduction to Dipole moment.	CO 4	T1:3.1 R2:3.7
15	Write the expression for potential and electric field intensity due to an electric dipole.	CO 4	T1:3.2-3.3 R2:3.7
16	Find torque on an electric dipole in an electric field.	CO 4	T1:3.4 R2:3.7
17	Study behavior of conductors in an electric field.	CO 5	T1:4.1-4.2 R2:4.1
18	Understand electric field inside a dielectric material.	CO 5	T1:4.3,4.5 R2:5.1

19	Discuss on polarization, conductor and dielectric.	CO 5	T1:4.3.2,4.3.3 R2:5.2
20	Derive dielectric boundary conditions.	CO 5	T1:4.6 R2:5.4
21	Calculate capacitance of parallel plate and spherical and coaxial capacitors with composite dielectrics.	CO 5	T1:3.5.2-3.5.5 R2:4.3-4.4
22	Estimate capacitance of parallel plate and spherical and coaxial capacitors with composite dielectrics.	CO 5	T1:3.5.2-3.5.51 R2:4.3-4.4
23	Derive the expressions for energy stored and energy density in a static electric field.	CO 5	T1:3.5.7-3.5.8 R2:4.5
24	Define current density, conduction and convection current densities.	CO 5	T1:4.7-4.8 R2:6.1
25	Deduce Ohm's law in point form, equation of continuity.	CO 5	T1:4.9-4.10 R2:6.2
26	Introduction to static magnetic fields.	CO 6	T1:5.1-5.2 R2:7.1-7.2
27	State Biot-Savart's law and magnetic field intensity.	CO 6	T1:5.3-5.4 R2:7.4
28	Determine magnetic field intensity due to a straight current carrying filament.	CO 6	T1:5.4-5.7 R2:7.4
29	Determine magnetic field intensity due to circular.	CO 6	T1:5.4-5.7 R2:7.4
30	Find magnetic field for square and solenoid current carrying wire.	CO 6	T1:5.4-5.7 R2:7.4
31	Relation between magnetic flux, magnetic flux density and magnetic field intensity.	CO 6	T1:5.2.7 R2:7.3
32	Deduce Maxwell's second equation, div (B)=0.	CO 6	T1:5.8 R2:7.3
33	Determine magnetic field intensity due to an infinite sheet of current and a long current carrying filament.	CO 6	T1:6.3-6.4
34	Find magnetic field intensity due to an infinite sheet of current and a long current carrying filament.	CO 6	T1:6.3-6.4 R2:7.4
34-A	State point form of Ampere's circuital law.	CO 6	T1:6.1 R2:7.7
35	Deduce Maxwell's third equation, Curl (H)=Jc	CO 6	T1:6.2 R2:6.3
36	Estimate field due to a circular loop, rectangular and square loops.	CO 6	T1:6.3-6.4 R2:7.8
37	Determine field due to a circular loop, rectangular and square loops.	CO 6	T1:6.3-6.4 R2:7.8
38	Expression for force due to Moving charges in a magnetic field, Lorentz force equation.	CO 7	T1:7.1-7.4 R2:8.1
39-40	Expression for force on a current element in a magnetic field, force on a straight and a long current carrying	CO 7	T1:7.3,7.5-7.7 R2:8.6
41	Find force between two straight long and parallel current carrying conductors.	CO 7	T1:7.5-7.7 R2:8.6
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45	Define vector magnetic potential due to simple configurations.	CO 9	T1:8.2 R2:7.12-7.13

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57	Analysis of wave equation in phasor form.	CO 12	R4:11.1
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60	Deducing wave equation in conductors and dielectrics.	CO 12	R4:11.2
61	State skin effect and derive pointing theorem.	CO 12	R4:11.4

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