INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**ELECTRO MAGNETIC FIELDS**			
Course Code	**R13 – A30403**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	01	-	4
Course Coordinator	Ms.S.Ranjitha, Assistant professor, ECE			
Team of Instructors	Ms.S.Ranjitha, Assistant professor, ECE			

I. COURSE OVERVIEW

This course deals with mainly introduction of the concepts of electric field and magnetic fields and their applications and also in the development of theory for power transmission lines and electrical machines.

II. PREREQUISITES

Level	Credits	Periods/week	prerequisite
UG	**4**	**4**	**Knowledge of electric field and magnetic fields**

III. MARKS DISTRIBUTION

Session marks	University end exam marks	Total marks
There shall be two mid tem examinations. Each id term exam consists of subjective type and objective type test. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain four questions; the student has to answer two out of them. Each carrying 5 marks The objective test paper Is prepared by JNTUH, which consists of 20 questions each carrying 0.5 marks and total of 10 marks. The student is assessed by giving two assignments, one, after completion of 1 to 2 1/2 units and the second, after the completion of 2 1/2 to 5 units each carrying 5 marks. On the total the internal marks are 25. The average of two internal tests is the final internal marks. The external question paper is set by JNTUH consisting of part –A and part-B. Where part consists of short answer questions carrying total marks of 25 and part part-B consists of 5 essay type questions consists of internal choice each carrying 10 marks and the total of 50. The total external marks are 75.	75	100

IV. EVALUATION SCHEME:

S.No	Component	Duration	Marks
1	I mid examination	90 minutes	20
2	I assignment	--	05
3	II mid examination	90 minutes	20
4	II assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES

At the end of the course, the students will be able to:

I. Understand the knowledge of Electromagnetic field theory that allows the student to have a solid theoretical foundation.
II. Able to do in the future to design emission, propagation and reception of electro- magnetic wave system.
III. To identify formulate and solve fields and electromagnetic waves propagation problems in a multi disciplinary frame individually or as a member of a group.
IV. To provide the students with a solid foundation in engineering fundamentals required to solve problems and also to pursue higher studies.
V. Understand the knowledge of tie varying magnetic fields.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. **Solve** the problems in different EM fields.
2. **Design** a programming to generate EM waves subjected to the conditions
3. **Understand** the applications of EM Waves in different domains and to find the time average power density
4. **Solve** Electromagnetic Relation using Maxwell Formulae,
5. **Study** Electro Static and Magnetic to Static circuits using Basic relations
6. **Analyze** moving charges on Magnetic fields
7. **Design** circuits using Conductors and Dielectrics
8. **Understand** time varying fields
9. **Analyze** Maxwell equations for time variant fields

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments
PO2	**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.	H	Exercises
PO3	**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.	N	-----

PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	N	-------
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	S	Discussion, Seminars
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	H	Design exercise, Prototypes
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	H	Exercise, Seminars, Discussions
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	S	Discussions
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	-----
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	S	Seminars, Discussions
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	H	Workshops, Prototypes
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	S	Seminar, Discussions

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency Assessed by
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	S	Lectures, Assignments
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	N	------
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Guest Lectures

N - None **S - Supportive** **H – Highly Related**

IX. SYLLABUS:

UNIT – I

Electrostatics: Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Guass's law – Application of Guass's Law – Maxwell's first law, div (D)=ρv Laplace's and Poison's equations – Solution of Laplace's equation in one variable.

UNIT – II

Conductors, Dielectrics and Capacitance: Electric dipole – Dipole moment – potential and EFI due to an electric dipole – Torque on an Electric dipole in an electric field – Behavior of conductors in an electric field – Conductors and Insulators. Electric field inside a dielectric material – polarization – Dielectric – Conductor and Dielectric – Dielectric boundary conditions, Capacitance – Capacitance of parallel plate and spherical and co- axial 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.

UNIT – III

Magneto Statics: Static magnetic fields – Biot-Savart's law –- Magnetic field intensity (MFI) – MFI due to a straight current carrying filament – MFI due to circular, square and solenoid current – Carrying wire – Relation between magnetic flux, magnetic flux density and MFI – Maxwell's second Equation, div(B)=0.
Ampere's circuital law and its applications: viz. MFI 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.

UNIT-IV

Force in Magnetic Fields and Magnetic Potential: Magnetic force - 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. Scalar Magnetic potential and its limitations – vector magnetic potential and its properties – vector magnetic potential due to simple configurations – vector Poisson's equations. Self and Mutual inductance – Neumann's formulae – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field. Introduction to permanent magnets, their characteristics and applications.

UNIT – V

Time Varying Fields : Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point forms – Maxwell's fourth equation, Curl (E)=-□B/□t – Statically and Dynamically induced EMFs – Simple problems -Modification of Maxwell's equations for time varying fields – Displacement current .

TEXT BOOKS:

1. "Engineering Electromagnetics" William H. Hayt & John. A. Buck McGraw-Hill Companies.
2. "Principles of Electromagnetics", Sadiku, Oxford Publications.

REFERENCES:

1. "Introduction to Electro Dynamics",D J Griffiths, Prentice-Hall of India Pvt.Ltd.
2. "Electromagnetic Fields", U.A Bakshi, Technical Publications.
3. "Electromagnetics",J. D Kraus Mc Graw-Hill companies.
4. "Electromagnetism-Problems with solutions", Ashutosh Pramanik, PHI Learning.
5. "Electromagnetics-Problems and solutions", William H. Hayt & John. A. Buck McGraw-Hill Companies.

X. COURSE PLAN:

The course plan is meant as a guideline. There may be probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1	To understand the Coordinate systems	Static Electric Fields: Introduction to Co-ordinate Systems – Rectangular – Cylindrical and Spherical Co-ordinate systems	T2:1.1-1.5
2	Introduce the different form of integrals with examples	Introduction to line, Surface and Volume Integrals	T2:2.3
3	To Understand the basics in Electrostatic fields	static Fields - Definition of Electric Field Intensity (EFI) – EFI due to a line and a surface	T2:3.3
4	Understand the Coulomb's law	charge Coulomb's Law	T2:3.2
5	Obtain the equation for a Work done in moving a point charge in an electrostatic field	Electric Work done in moving a point charge in an electrostatic field	T2:3.4
6	To Acquire the Knowledge on Electric potential and its properties	Potential -Properties of potential function – Potential due to an infinite uniformly charged line	T2:3.7
7	To Know about the concept of Electric Dipole	Electric dipole – Dipole moment - Potential due to electrical dipole- Torque on an Electric dipole in an electric field	T2:3.9
8	Ability to understand the Gauss's law	Potential gradient – Gauss's law – Applications of Gauss's Law – Maxwell's first law, div D=rv	T2:3.5
9	To know the applications Electromagnetic Field Theory	ELECTROMAGNETIC FIELD THEORY Applications And Differences between Circuit theory And Field Theory	T2:6.0
10	To Understand the basics in static magnetic fields and Biot-savart's law	STATIC MAGNETIC FIELDS :Biot-Savart's law in vector form	T2:6.2
11-12	Ability to calculate MFI for different applications like wire carrying current for a finite length	Magnetic Field intensity(MFI) due to a finite and infinite wire carrying a current I	T2:6.2
13	Ability to calculate MFI for different applications like circular and rectangular loop carrying a current I	MFI due to circular and rectangular loop carrying a current I-	T2:7.6
14	Understand how to obtain the Maxwell's second Equation	Relation between magnetic flux, magnetic flux density and MFI –	T2:6.3

		Maxwell's second Equation, div(B)=0.	
15	To Understand the Ampere's circuital law	Ampere's circuital law	T2:6.3
16	Ability to calculate MFI for different applications like an infinite sheet of current by Ampere's law	Ampere's circuital law and its applications viz. MFI due to an infinite sheet of current and a long current	T2:6.4
17	Ability to calculate MFI for different applications like long current carrying filament by Ampere's law	MFI due to a long current carrying filament	T2:6.4
18	To understand the Maxwell's Equation	Point form of Ampere's circuital law	T2:6.4
19	Ability to apply the concepts to solve the problems	Simple problems on above topic	T2:6.0
20	Ability to apply the concepts for the Practical applications	Simple problems	T2:6.0
21	To Introduce the concept of Electric And Magnetic Fields in materials	Electric And Magnetic Fields In Materials	T2:7.0
22	Understand the Laplace's and Poison's equations and their derivations	Laplace's and Poison's equations – Solution of Laplace's equation in one variable	T2:5.2
23	To Understand the Behavior of conductors in an electric field	Behavior of conductors in an electric field – Conductors and Insulators.	T2:4.2
24	Ability to calculate the capacitance for different forms of capacitances like parallel plate.	Capacitance - Capacitance of parallel plate, spherical and co-axial capacitors	T2:5.14
25	Ability to calculate the capacitance for different forms of capacitances like parallel plate	co-axial capacitors with composite dielectrics	T2:5.15
26	Understand the concept of Energy stored in a static electric field	Energy stored and energy density in a static electric field	T2:5.18
27	Understand the concept Electric field inside a dielectric material	Electric field inside a dielectric material	T2:4.6
28	To Improve the problem solving skills	Polarization & Problems	T2:4.5
29	To understand the Boundary conditions for electric fields between Dielectric-Dielectric	Boundary conditions for electric fields	T2:4.8
30	To understand the Boundary conditions for electric fields between dielectric- conductor	Boundary conditions for electric fields	T2:4.8
31	To understand the Boundary conditions for electric fields between Free space -conductor	Boundary conditions for electric fields	T2:4.8
32	To Understand the concept of Electric Current-Current density related to field theory	Electric Current-Current density – conduction and Convection current densities	T2:4.3
33	To Understand the concept of OHM's law related to field theory	Ohm's law in point form	R2:5.4.1
34	Know the Equation of continuity	Equation of continuity	R2:4.7
35	Ability to calculate the Inductance	Self and Mutual inductance	R2:7.7

36	Understand the Neumann's formulae	Neumann's formulae	R2:8.10
37	Ability to calculate the Inductance for a solenoid	Determination of self-inductance of a solenoid	R2:8.11
38	Ability to calculate the Inductance for a solenoid	Determination of self-inductance of a toroid	R2:8.12
39	Ability to calculate the Mutual Inductance	Mutual inductance between a straight long wire and a square loop wire in the same plane	R2:8.14
40	To calculate the energy stored in Magnetic field	energy stored and density in a magnetic field	R2:8.15
41	To Improve the problem solving skills relates to the inductance	Simple problems on above topic	R2:8.0
42	A. Understand the concept of Magnetic force	Force In Magnetic Fields	T2:7.2
43	A. Understand the concept of Moving charges in a Magnetic field	Magnetic force - Moving charges in a Magnetic field	T2:8.2
44	A. Understand the concept of Lorentz force equation	Lorentz force equation	T2:8.3
45	Know the equation for Magnetic force	Force on a current element in a magnetic field	T2:8.3
46	Know the equation for Magnetic force on a straight and a long current carrying conductor	Force on a straight and a long current carrying conductor in a magnetic field	T2:8.4
47	Know the equation for Magnetic force between two straight long and parallel current carrying conductors	Force between two straight long and parallel current carrying conductors	T2:8.4
48	To Know the concept of Magnetic dipole	Magnetic dipole and dipole moment	T2:7.4
49	Understand the concept of Magnetic dipole	A differential current loop as a magnetic dipole	T2:8.6.1
50	Introduce the Magnetic potential for magnetic fields	Magnetic Potential	T2:7.13
51	To Know the Scalar & Vector Magnetic Potential	Scalar Magnetic Potential and its limitations- Vector Magnetic Potential.	T2:7.13.1
52	Calculate the Torque on a current loop placed in a magnetic field	Torque on a current loop placed in a magnetic field	T2:7.13.3
53	Improve the Numerical Skills based on above topics	Simple problems on above topic	R2:7.0
54	Introduce the Time Varying Fields	Time varying fields	R2:9.0
55	To understand the Faraday's laws of electromagnetic induction	Faraday's laws of electromagnetic induction – Its integral and point forms	R2:9.2
56	Know how to Obtain the Faraday's laws of electromagnetic induction and Its integral and point forms	Faraday's laws of electromagnetic induction – Its integral and point forms	R2:9.10
57	Ability to understand the Types of induced EMF's by the Field theory	Statically & Dynamically induced emfs	R2:9.2.1
58	Understand the equation for Statically induced EMFs	Maxwell's fourth equation, Curl (E)=-¶B/¶t – Statically induced EMFs	R2:9.2.2
59	Understand the equation for Dynamically induced EMFs	Dynamically induced emfs	R2:9.2.2

60	To Improve the Numerical skills towards the time varying Fields	Simple problems	R2:9.0
61	To Understand the Maxwell's Equations	Maxwell's Four equations	R2:9.5
62	To Understand the Maxwell's Equations for time varying fields	Modification of Maxwell's equations for time varying fields	R2:9.5

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I		S				H	H	H		S	H	S	S	S	S
II	H	H				S	S	S		S	S	S	S	H	S
III		S				H	H	H		S	H	S	S	H	S
IV	H	H				S	S	S		S	S	S	S	S	S
V		H				S	S	S		S	H	S			

S – Supportive **H - Highly Related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	S				S							S			
2			H								S				
3				H								S			
4	S									S					
5		S	H												
6	H			S		H						S			
7		H	S								S				
8			H							S					
9										S					

S – Supportive **H - Highly Related**

Prepared by: Ms.S.Ranjitha, Assistant professor

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