INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	ELECTROMAGNETIC WAVES AND TRANSMISSION LINES				
Course Code	AECB13				
Programme	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. K C Koteswaramma, Assistant Professor				
Course Faculty	Dr. P Ashok babu, Professor&HOD. Ms. A Usharani, Assistant Professor Ms. M Sreevani, Assistant Professor				

I. COURSE OVERVIEW:

The course will make them learn the basic concepts of electric field, magnetic field and their behavior in 3D-Coordinate systems. Starting from electrostatics and magneto statics they will learn to understand basic law's that has a specified relation to derive Maxwell's equations. They will be able to derive electromagnetic wave equations by using Maxwell's equations. They will learn to understand the behavior of transmission lines and their applications to wave propagation. This course provides a platform for advanced courses like antennas and propagation, microwave engineering. Greater Emphasis is placed to understand the waves travelling through co-axial cables, optical fibre cables.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHSB02	I	Linear Algebra and Calculus	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Electromagnetic Waves and Transmission Lines	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 modules and each module 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 module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: 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.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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	Quiz
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	Assignments
PO 4	**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.	2	Term paper/ Assignments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	3	Seminar
PSO 2	**Problem-Solving Skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	2	Seminar exercises

PSO 3	**Successful Career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real- world applications using optimal resources as an Entrepreneur.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the 3D vector co-ordinate systems and electromagnetic field concepts.
II	Analyze the importance of Maxwell's equations in electromagnetic theory andwave propagation.
III	Study the propagation characteristics of electromagnetic waves at boundary.
IV	Demonstrate the ability to compute various parameters for transmission lines using smith chart and classical theory.

IX. COURSE OUTCOMES

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand coloumb's lawand gauss's law to different charge distributions, it's applications and applications of Laplace's and Poisson's equations	CLO 1	Understand the different types of 3D co- ordinate systems, scalars and vectors, physical significance of divergence, curl and gradient
		CLO 2	Illustrate the concepts of coloumb's law and gauss's law to different charge distributions like point charge, line charge, surface charge and volume charge also analyze its applications.
		CLO 3	Understand the applications of Laplace's and Poisson's equations to solve problems on capacitance of different charge distributions.
CO 2	Evaluate the physical interpretation of Maxwell's equations and applications for various fields.	CLO 4	Illustrate the physical significance of Biot- Savart's law and Ampere's Circuit law for different current distributions and analyze its applications.
		CLO 5	Evaluate the physical significance of Faraday's law and interpretation of Maxwell's equations for time-varying fields.
		CLO 6	Derive the boundary conditions between different media like dielectric to dielectric, dielectric conductor interfaces .
CO 3	Understand the behavior of electromagnetic waves incident on the interface between two different media.	CLO 7	Analyze and apply the Maxwell's equations to derive electromagnetic wave equations for different media.
		CLO 8	Understand the behavior of electromagnetic waves incident on the interface between two different media.
		CLO 9	Formulate and analyze problems in different media such as lossy, lossless with boundaries using uniform plane waves.

COs	Course Outcome	CLOs	Course Learning Outcome
CO 4	Understand the significance of transmission lines and concept of attenuation, loading, and analyze the loading technique to the transmission lines.	CLO 10	Understand the significance of transmission lines and its types, derive their primaryconstants and secondary constants.
		CLO 11	Understand the concept of attenuation, loading, and analyze the loading techniqueto the transmission lines.
		CLO 12	Understand the design of various transmission lines characterization.
CO 5	Formulate and analyze the smith chart to estimate impedance, VSWR, reflection coefficient, OC and SC lines.	CLO 13	Summarize the impedance transformation for different lengths such as λ/4,λ/2,λ/8 transmission lines
		CLO 14	Understand the design of ultra high frequency transmission lines for different applications by using single and double stub matching techniques
		CLO 15	Formulate and analyze the smith chart to estimate impedance, VSWR, reflection coefficient, OC and SC lines.
		CLO 16	Apply the concept of electromagnetic fields to understand and analyze land mobile communications.
		CLO 17	Acquire the knowledge and develop capability to succeed national and international level competitive examinations.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AECB13.01	CLO 1	Understand the different types of 3D co-ordinate systems, scalars and vectors, physical significance of divergence, curl and gradient	PO 1	2
AECB13.02	CLO 2	Illustrate the concepts of coloumb's lawand gauss's law to different chargedistributions like point charge, line charge, surface charge and volume charge. Analyze its applications.	PO1,PO2	2
AECB13.03	CLO 3	Understand the applications of Laplace's and Poisson's equations to solve problems on capacitance of differentcharge distributions.	PO1, PO2, PO4	2
AECB13.04	CLO 4	Illustrate the physical significance of Biot-Savart's law and Ampere's Circuit law for different current distributions and analyze its applications	PO 2, PO4	3
AECB13.05	CLO 5	Evaluate the physical interpretation ofMaxwell's equations and applications for various fields like antennas and wave guides.	PO1,PO4	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AECB13.06	CLO 6	Derive the boundary conditions between different media like dielectric to conductor, conductor to free space.	PO 2	2
AECB13.07	CLO 7	Analyze and apply the Maxwell's equations to derive electromagnetic wave equations for differentmedia.	PO 2, PO4	2
AECB13.08	CLO 8	Understand the behavior of electromagnetic waves incident on the interface between two different media.	PO 1	2
AECB13.09	CLO 9	Formulate and analyze problems in different media such as lossy, lossless with boundaries using uniform plane waves.	PO 2	2
AECB13.10	CLO 10	Understand the significance of transmission lines and its types, derive their primary constants and secondary constants.	PO 1	2
AECB13.11	CLO 11	Understand the concept of attenuation, loading, and analyze the loading technique to the transmission lines.	PO 1, PO 2	2
AECB13.12	CLO 12	Understand the design of various transmission lines with respect to distortion, loss, impedance matching, and VSWR and reflection coefficient.	PO1	3
AECB13.13	CLO 13	Summarize the impedance transformation for different lengths such as$\lambda/4,\lambda/2,\lambda/8$ transmission lines.	PO 2	3
AECB13.14	CLO 14	Understand the design of ultra high frequency transmission lines for different applications by using single and double stub matching techniques.	PO1	3
AECB13.15	CLO 15	Formulate and analyze the smith chart to estimate impedance, VSWR,reflection coefficient, OC and SC lines.	PO2	2
AECB13.16	CLO 16	Apply the concept of electromagnetic fields to understand and analyze land mobile communications.	PO1,PO2	2
AECB13.17	CLO 17	Acquire the knowledge and develop capability to succeed national and international level competitive examinations.	PO1,PO4	2

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 4	PSO 1	PSO 2	PSO 3
CO 1	3	3			3	
CO 2	2	3			3	2
CO 3	2	3	2		3	
CO 4	2	2			3	
CO 5	2	2	2	2	3	2

3 = High; 2 = Medium; 1 = Low

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

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	2	2											1		
CLO 3	3	1		1									1		
CLO 4		2		1										2	
CLO 5	1			2											
CLO 6		2											3		
CLO 7		2		1									1		
CLO 8	2												1		
CLO 9		2											2	2	
CLO10	3												1		
CLO 11	2	2													
CLO 12	2												2		
CLO 13		2													
CLO 14	2												1		
CLO 15		2													
CLO 16	2	2											3	2	
CLO 17	2			2									1		

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO4, PSO1, PSO2	SEE Exams	PO1, PO2, PO4, PSO1, PSO2	Assignments	PO1, PO2, PO4	Seminars	PO1, PO2, PO4, PSO1, PSO2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO4, PSO1, PSO2						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

MODULE-I	**ELECTROSTATICS**	**Classes-09**
Electrostatics: Coulomb‟s law, electric field intensity, fields due to different charge distributions; Electric flux density, Gauss law and its applications; Scalar electric potential; Energy density, illustrative problems; Conductors and dielectrics-characterization; Convection and conduction currents; Dielectric constant, isotropic and homogeneous dielectrics; Continuity equation and relaxation time, conductivity, power absorbed in conductor, Poisson‟s and Laplace‟s equations; Capacitance: Parallel plate, co axial, spherical capacitors; Method of images; Illustrative problems.		
MODULE-II	**MAGNETOSTATICS**	**Classes-09**
Magnetostatics: Biot-savart law; Ampere‟s circuital law and applications; Magnetic flux density; Magnetic scalar and vector potentials; Forces due to magnetic fields; Ampere‟s force law; Boundary conditions: Dielectric- dielectric, dielectric conductor interfaces; Inductances and magnetic energy; Illustrative problems; **Maxwell's equations (Time varying fields):** Faraday‟s law; Inconsistency of ampere‟s law for time varying fields and definition for displacement current density; Maxwell‟s equations in differential form, integral form and word Statements.		
MODULE-III	**UNIFORM PLANE WAVES**	**Classes-09**
Uniform plane waves: Wave equations for conducting and perfect dielectric media; Relation between E and H; Wave propagation in lossless and conducting media, Loss tangent, Intrinsic impedance; Skin depth; Polarization, Illustrative problems. **Reflection/refraction of plane waves:** Reflection and refraction at normal incidence, reflection and refraction at oblique incidence; Standing waves; Brewster angle, critical angle, total internal reflection, surface impedance; Poynting vector and poynting theorem-applications; Power loss in plane conductor;Illustrative problems.		
MODULE-IV	**TRANSMISSION LINE CHARACTERISTICS**	**Classes-09**

Transmission line characteristics: Types; Transmission line parameters; Transmission line equations; Characteristic impedance, propagation constant; Phase and group velocities; Infinite line concepts, Loss less/low loss transmission line characterization; condition for distortion less and minimum attenuation in transmission lines; Loading: Types of loading; Illustrative problems.		
MODULE-V	**UHF TRANSMISSION LINES AND APPLICATIONS**	**Classes-09**
UHF transmission lines and applications: Input impedance relations; SC and OC lines; Reflection coefficient, VSWR; UHF lines as circuit elements, λ/4, λ/2 and λ/8 lines, impedance transformations, significance of Z_{min} and Z_{max}; Smith chart: Configuration and applications; Single and double stub matching; Illustrative problems.		
TEXT BOOKS:		
1. Matthew N.O. Sadiku, "Elements of Electromagnetic", Oxford University Press, 4th Edition,2009. 2. E.C. Jordan, K.G. Balmain, "Electromagnetic waves and Radiating Systems", PHIlearning, 2nd Edition, 2000. 3. Umesh Sinha, Satya Prakashan, "Transmission lines and Networks", Tech IndiaPublications, 1st Edition, 2010.		
REFERENCE BOOKS:		
1. Nathan Ida, "Engineering Electromagnetic", Springer (India) Pvt. Ltd, 2nd Edition,2005 2. William H. Hayt Jr., John A. Buck, "Engineering electromagnetic", Tata McGraw Hill, 7th Edition, 2006. 3. G. Sashibushana Rao, "Electromagnetic Field theory and Transmission Lines, Wiley India,2013. 4. 4.John D. Ryder, "Networks, Lines and Fields", PHI learning, 2nd Edition,1999		

XVI. COURSE PLAN:

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

Lecture No.	Topics to be covered	Course Learning Outcomes	Reference
1	Understand the different types of 3D co-ordinate systems and transformations.	CLO 1	T1-3.1 to 3.8R2- 1.8 to 1.9
2	Remember Vector calculus: del operator;	CLO 1	T1-3.1 to 3.8 R2- 1.8 to 1.9
3	gradient, divergence and curl of a vector.	CLO 2	T1-3.1 to 3.8 R2- 1.8 to 1.9
4	Illustrate the concepts of coulomb's law and gauss's law to Point, line charges.	CLO 3	T1-3.1 to 3.8 R2- 1.8 to 1.9
5-7	Illustrate the concepts of coulomb's law and gauss's law to surface charges.	CLO 2	T1-3.1 to 3.8 R2- 1.8 to 1.9
8	Illustrate the concepts of coulomb's law and gauss's law to volume charges.	CLO 2	T1-3.1 to 3.8 R2- 1.8 to 1.9

9	Understand the concepts of Electric flux density.	CLO 3	T1-3.1 to 3.8 R2- 1.8 to 1.9
10	Remember the concept of Scalar electric potential.	CLO 2	T1-3.1 to 3.8 R2- 1.8 to 1.9
11	Illustrate the concept of Energy density, problems;	CLO 2	T1-3.1 to 3.8 R2- 1.8 to 1.9
12-13	Understand the concepts of Conductors and dielectrics-characterization; Convection and conduction currents;	CLO 2	T1-3.1 to 3.8 R2- 1.8 to 1.9
14	Unserstand the concept of Dielectric constant, isotropic and homogeneous dielectrics; Continuity equation and relaxation time, conductivity.	CLO 3	T1-3.1 to 3.8 R2- 1.8 to 1.9
15	Remember the concept of power absorbed in conductor, Poisson's and Laplace's equations;	CLO 3	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
16-17	Remember the concept of Capacitance: Parallel plate, co axial, spherical capacitors;	CLO 3	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
18	Unserstand the concept of Method of images; Illustrative problems.	CLO 1	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
19	Remember the concept of **Magnetostatics:** Biot-savart law;	CLO 4	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
20	Ampere's circuital law and applications; Magnetic flux density;	CLO 4	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
21	Remember the concept of Magnetic scalar and vector potentials; Forces due to magnetic fields;	CLO 5	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
22	Ampere's force law; Boundary conditions:	CLO 6	T1-4.3 to 4.4 ,4.6,4.7 R2-7.1
23	Remember the concept of Dielectric- dielectric, dielectric conductor interfaces;	CLO 5	T1-7.1 to 7.2, 4.8,7.6,7.8
24	Inductances and magnetic energy; Illustrative problems;	CLO 4	T1-7.1 to 7.2, 4.8,7.6,7.8
25	Maxwell's equations (Time varying fields): Faraday's law;	CLO 5	T1-7.1 to 7.2, 4.8,7.6,7.8
26	Inconsistency of ampere's law for time varying fields.	CLO 5	T1-7.1 to 7.2, 4.8,7.6,7.8
27	Remember the concept of definition for displacement current density;	CLO 6	T1-7.1 to 7.2, 4.8,7.6,7.8
28	Maxwell's equations in differential form, integral form and word Statements.	CLO 6	T1-8.2 to 8.5

29	**Uniform plane waves:** Wave equations for conducting and perfect dielectric media; .	CLO 7	T1-9.2 to 9.3
30	Remember the concept of Relation between E and H; Wave propagation in lossless and conducting media.	CLO 7	T1-9.3to 9.4
31	Loss tangent, Intrinsic impedance; Skin depth; Polarization, Illustrative problems.	CLO 8	T1-9.4 to 9.5
32	**Reflection/refraction of plane waves:** Reflection and refraction at normal incidence, reflection and refraction at oblique incidence;	CLO 8	T1-9.5 to 9.6
33	Standing waves; Brewster angle, critical angle, total internal reflection.	CLO 9	T1-9.6 to 9.7
34	surface impedance; Poynting vector and poynting theorem-applications; Power loss in plane conductor; Illustrative problems	CLO 9	T1-9.7 to 9.8
35	Unserstand the concept of surface impedance; Poynting vector and poynting theorem-applications;	CLO 10	T1-9.8 to 9.9
36	Power loss in plane conductor; Illustrative problems	CLO 11	T1-9.9 to 9.10
37	**Transmission line characteristics:** Types; Transmission line parameters;	CLO 12	T3 - 1.9 to 1.12
38	Transmission line equations; Characteristic impedance, propagation constant;	CLO 13	T3 - 1.9 to 1.15
39	Unserstand the concept of Phase and group velocities;	CLO 12	T3 - 1.9 to 1.17
40	Unserstand the concept of Infinite line concepts.	CLO 12	T3-5.4 to 5.5
41	Loss less /low loss transmission line characterization;	CLO 13	T3-5.4 to 5.7
42	condition for distortion less and minimum attenuation in transmission lines;	CLO 14	T3-5.4 to 5.8
43	Loading: Types of loading;	CLO 15	T3-5.4 to 5.10
44	Illustrative problems on transmission.	CLO 15	T3 - 1.9 to 1.17
45	UHF transmission lines and applications: Input impedance relations;	CLO 13	T3-5.4 to 5.10
46	Understand the concept of SC and OC lines;	CLO 13	T3 -3.5 to3.8
47-48	Reflection coefficient, VSWR;	CLO 15	T3-2.1 to 7.2
49	Understand the UHF lines as circuit elements, $\lambda/4$, $\lambda/2$ and $\lambda/8$ lines,	CLO 15	T3-2.1 to 7.2
50-51	Understand the impedance transformations,	CLO 13	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to

			6.14
52	Understand the significance of Z_{min} and Z_{max};	CLO 14	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to 6.14
53-54	Unserstand the concept of Smith chart: Configuration and applications;	CLO 15	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to 6.14
55	Unserstand the concept of Single stub matching;	CLO 15	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to 6.14
56	Unserstand the concept of double stub matching;	CLO 15	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to 6.14
57	Illustrative problems.	CLO 15	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to 6.14
58	Illustrate Problems on transmission lines.	CLO 15	T3-2.1 to 7.2 T3-6.6 to 6.8, T1-6.12to 6.14

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	3D co-ordinate systems and classifications	Seminars	PO 1	PSO 1
2	Waveguides and its types, modes, applications	Seminars / NPTEL	PO 4	PSO 2
3	Microchip transmission lines	Guest lectures	PO 2	PSO 1

Prepared by:

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