INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**ANTENNAS AND PROPAGATION**				
Course Code	AEC011				
Programme	B.Tech				
Semester	V	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. A Usharani, Assistant Professor				
Course Faculty	Dr. V Sivanagaraju, Professor Ms. K C Koteswaramma, Assistant Professor				

I. COURSE OVERVIEW:

Antennas have become increasingly important to our society until now they are indispensible. This course will cover the fundamentals of antenna, radiation phenomenon, loop antennas, dipole antennas, very high frequency (VHF), ultra-high frequency(UHF), and microwave antennas like Yagi - Uda, helical antenna, reflector antenna, micro strip antenna, lens antenna, antenna arrays broadside and end fire, antenna measurements to measure the antenna parameters, wireless communication maintained through ground, space and sky.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEC011	IV	Electromagnetic Theory and Transmission Lines	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Antennas and Propagation	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 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz / Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Quiz / AAT**	
CIA Marks	25	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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

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	Lectures and Assignments
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.	2	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	Lab related Exercises

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	Lectures and Assignments
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.	3	Lectures and Assignments
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:

S.No	Description
I	Be Proficient in the radiation phenomena associated with various types of antennas and understand basic terminology and concepts of antennas along with emphasis on their applications.
II	Analyze the electric and magnetic field emission from various basic antennas with mathematical formulation of the analysis.
III	Explain radiation mechanism of different types of antennas and their usage in real time field.
IV	Justify the propagation of the waves at different frequencies through different layers in the existing layered free space environment structure.

IX. COURSE OUTCOMES (COs):

COs	Course Outcomes	CLO's	Course Learning Outcome
CO1	Discuss about the radiation mechanism in wire antennas and Analyze the concept of antenna properties based on reciprocity theorem.	CLO 1	Discuss about the radiation mechanism in single wire, double wire antennas and the current distribution of thin wire antenna.
		CLO 2	Discuss the different parameters of an antenna like radiation patterns, radiation intensity, beam efficiency, directivity and gain etc,.
		CLO 3	Analyze the concept of antenna properties based on reciprocity theorem; evaluate the field components of quarter wave monopole and half wave dipole.
CO2	Understanding the significance of loop antennas uniform linear arrays and helical antennas.	CLO 4	Understand the significance of loop antennas in high frequency range and its types; derive their radiation resistances and directivities.
		CLO 5	Discuss the uniform linear arrays such as broadside array and yagi array, derive their characteristics.
		CLO 6	Analyze the practical design considerations of monofilar helical antenna in axial and normal modes.
CO3	Desribe the various types of Microwave antennas and their applications.	CLO 7	Discuss the various types of Microwave antennas and analyze the design consideration of pyramidal horn.
		CLO 8	Analyze the concept of complementary in slot antennas using Babinet's principle and understand the impedance of slot antennas.
		CLO 9	Understand the significance, features and characteristics of micro strip patch antennas, analyze the impact of different parameters on

COs	Course Outcomes	CLO's	Course Learning Outcome
			characteristics.
CO4	Analyze the reflector Antennas with their applications, measure the different antenna parameters.	CLO 10	Understand and analyze the reflectors are widely used to modify the radiation pattern as a radiating element, its types.
		CLO 11	Discuss various concepts related to antennas such as feed methods like front feed, rear feed, offset feed and aperture blockage.
		CLO 12	Discuss various methods and techniques for experimental measurements of antennas such as pattern measurement, directivity measurement, gain measurement etc.
CO5	Analyze the structure of atmosphere for the wave propagation.	CLO 13	Understand the wave propagation through the complete study of the wave by the nature and characteristics of media during the wave travels.
		CLO 14	Understand the space wave propagation focusing on field strength variation with distance and height, effect of earth's curvature, absorption and super refraction.
		CLO 15	Analyze the structure of ionosphere and understand the sky wave propagation through refraction and reflection by ionosphere.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLOs	At the end of the course, the student will have the ability to:	POs Mapped	Strength of Mapping
AEC011.01	CLO 1	Discuss about the radiation mechanism in single wire, double wire antennas and the current distribution of thin wire antenna.	PO 1	3
AEC011.02	CLO 2	Discuss the different parameters of an antenna like radiation patterns, radiation intensity, beam efficiency, directivity and gain etc.	PO 1	3
AEC011.03	CLO 3	Analyze the concept of antenna properties based on reciprocity theorem; evaluate the field components of quarter wave monopole and half wave dipole.	PO 2	3

CLO Code	CLOs	At the end of the course, the student will have the ability to:	POs Mapped	Strength of Mapping
AEC011.04	CLO 4	Understand the significance of loop antennas in high frequency range and its types; derive their radiation resistances and directivities.	PO 1	3
AEC011.05	CLO 5	Discuss the uniform linear arrays such as broadside array and end fire array, derive their characteristics.	PO 1	3
AEC011.06	CLO 6	Analyze the practical design considerations of horn antennas and monofilar helical antenna in axial and normal modes.	PO 2, PO 4	2
AEC011.07	CLO 7	Discuss the various types of Microwave antennas and analyze the design consideration of pyramidal horn.	PO 2, PO 4	2
AEC011.08	CLO 8	Analyze the concept of complementary in slot antennas using Babinet's principle and understand the impedance of slot antennas.	PO 4	2
AEC011.09	CLO 9	Understand the significance, features and characteristics of micro strip patch antennas, analyze the impact of different parameters on characteristics.	PO 2	3
AEC011.10	CLO 10	Understand and analyze the reflectors are widely used to modify the radiation pattern as a radiating element, its types.	PO 1	3
AEC011.11	CLO 11	Discuss various concepts related to antennas such as feed methods like front feed, rear feed, offset feed and aperture blockage.	PO 2	3
AEC011.12	CLO 12	Discuss various methods and techniques for experimental measurements of antennas such as pattern measurement, directivity measurement, gain measurement etc.	PO 4	2
AEC011.13	CLO 13	Understand the wave propagation through the complete study of the wave by the nature and characteristics of media during the wave travels.	PO 1	3
AEC011.14	CLO 14	Understand the space wave propagation focusing on field strength variation with distance and height, effect of earth's curvature, absorption and super refraction.	PO 1	3
AEC011.15	CLO 15	Analyze the structure of ionosphere and understand the sky wave propagation through refraction and reflection by ionosphere.	PO 2	3

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)		
	PO1	PO2	PO4	PSO1	PSO2	PSO3
CO 1	3	3		3	2	
CO 2	3	2	2	2	2	
CO 3		3	2	2	2	
CO 4	3	3	2	2	3	
CO 5	3	3		3	3	

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

Course Learning Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												3		
CLO 2	2												2		
CLO 3	3													2	
CLO 4		2											3		
CLO 5		2											2		
CLO 6		3		2										3	
CLO 7				2										3	
CLO 8				2										2	
CLO 9		3											2		
CLO 10	3												3		
CLO 11		2											2		
CLO 12	2														
CLO 13	3												2		
CLO 14	2												3		
CLO 15		2												2	

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	PO 1 PO 2	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

Unit-I	**ANTENNA BASICS AND THIN LINEAR WIRE ANTENNAS**
Antenna fundamentals: Introduction, radiation mechanism, single wire, 2 wires, dipoles, current distribution on a thin wire antenna; Antenna Parameters, radiation patterns, patterns in principal planes, main lobe and side lobes, beam widths, radiation intensity, beam efficiency, directivity, gain and resolution, antenna apertures, aperture efficiency, effective height; Antenna properties based on reciprocity theorem; Thin linear wire antennas: Retarded potentials; Radiation from small electric dipole, Quarter wave monopole and half wave dipole, current distributions, evaluation of field components; power radiated, radiation resistance, beam widths, directivity, effective area and effective height; Natural current distributions, fields and patterns of thin linear center-fed antennas of different lengths; Illustrated problems.	
Unit-II	**LOOP ANTENNAS AND ANTENNA ARRAYS**
Loop Antennas: Introduction, small loop; Comparison of Far fields of small loop and short dipole; Radiation resistances and directivities of small and large loops. Antenna Arrays: Point sources, definition, patterns; Arrays of 2 isotropic sources, different cases; Principle of pattern multiplication; Uniform linear arrays - Broadside arrays; End-fire arrays; EFA with increased directivity; Derivation of their characteristics and comparison; BSAs with non-uniform amplitude distributions; General considerations and Binomial arrays; Folded Dipoles and their characteristics; Arrays with parasitic elements, Yagi-Uda array, Helical antennas- Helical geometry, Helix modes, Practical design considerations for monofilar Helical antenna in axial and normal modes.	
Unit-III	**VHF,UHF AND MICROWAVE ANTENNAS**
VHF, UHF and Microwave Antennas: Horn antennas- Types, Fermat‘s principle, optimum horns, design considerations of pyramidal horns; Illustrative problems; Lens antennas: Introduction, geometry of Non-metallic dielectric lenses zoning, tolerances, applications; Slot antenna, its pattern, Babinet‘s principle and complementary antennas, impedance of slot antennas. Microstrip Antennas: Introduction, features, advantages and limitations; Rectangular patch antennas- geometry and parameters, characteristics of micro strip antennas, Impact of different parameters on characteristics.	
Unit-IV	**REFLECTOR ANTENNAS AND ANTENNA MEASUREMENTS**
Reflector Antennas: Introduction, flat sheet and corner reflectors; Paraboloidal reflectors: Geometry, pattern characteristics, feed methods, reflector types- Related features; Illustrative problems. Antenna measurements: Introduction, concepts, reciprocity near and far fields; Coordinate system, sources of errors patterns to be measured; Pattern measurement arrangement directivity measurement; Gain measurements: Comparison method, absolute and 3-antenna methods.	
Unit-V	**RADIO WAVE PROPAGATION**
Wave Propagation - I: Introduction, definitions, categorizations , general classifications, different Modes of Wave Propagation; Ground wave propagation: Introduction, plane earth reflections, space and surface waves, wave tilt, curved earth reflections; Space wave propagation: Introduction, field strength variation with distance and height, effect of earth‘s curvature, absorption, super refraction, M-Curves, duct propagation,	

scattering phenomena, tropospheric propagation, fading and path loss calculations; Wave propagation – II: Sky wave propagation: Introduction, structure of ionosphere, refraction and reflection of sky waves by ionosphere; Ray path, critical frequency, MUF, LUF, OF, virtual height and skip distance; Relation between MUF and skip distance; Multi-hop propagation.
Text Books:
1. John D. Kraus, Ronald J. Marhefka, Ahmad S. Khan, Antennas and Wave Propagation‖, TMH, 4th Edition, 2010. 2. C.A. Balanis, Antenna Theory, John Wiley and Sons, 2nd Edition, 2001.
Reference Books:
1. E.C. Jordan, K.G. Balmain, Electromagnetic Waves and Radiating Systems‖, PHI, 2nd Edition,2000. 2. E.V.D. Glazier, H.R.L. Lamont, Transmission and Propagation‖, Her Majesty's Stationery Office, 1958. 3. F.E. Terman, Electronic and Radio Engineering‖, McGraw-Hill, 4th Edition, 1955. 4. K.D. Prasad, Satya Prakashan, Antennas and Wave Propagation, Tech India Publications,1st Edition, 2001.

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
1-5	Understand the Antenna basics and different definitions of an antenna, different applications of an antenna and about the electromagnetic spectrum	CLO 1	T1 : 2.1 to 2.2
6-10	Understand the Antenna parameters like radiation intensity, gain ,beam solid angle properties	CLO 2	T1 : 2.3 to2.10 R1: 9.1 to 9.3
11-17	Evaluate the field components of short dipole or small current element, linear antennas	CLO 3	T1 : 6.2 to 6.4
18-20	Understand the far field differences in loop and dipole antennas	CLO 4	T1:7.1 to 7.7
21-25	Analyze the principle of pattern multiplication in arrays and description of uniform linear array	CLO 5	T1:5.1 to5.12
26-29	Understand the operation of folded dipoles and their applications like yagi-uda antenna and helical antenna	CLO 6	R1: 9.4 to 9.6
30-35	Analyze the importance of antennas in microwave region(VHF antennas,UHF antennas)	CLO 7	T1: 8.2 to8.4
35-38	Analyze the concept of complementary in slot antennas using Babinet's principle	CLO 8	T1: 8.5 to8.10
39-40	Understand the operation of micro strip antennas and their characteristics	CLO 9	T1:14.1to14.3 R1: 9.8 to 9.9
41	Analyze the applications of micro strip antennas and their impact on different parameters	CLO 9	T1: 14.4 to14.6
42-43	Evaluate the performance of reflector antennas and its classification	CLO 10	T1: 9.1 to 9.3
44-45	Analyze the pattern characteristics and feed methods in reflector antennas	CLO 11	T1: 9.5 to 9.9 R1: 9.6 to 9.8
46-50	Evaluate the measurements of antennas like gain measurement, directivity measurement and pattern measurement	CLO 12	T1: 21.1 to21.3
51-55	Analyze the categorizations of wave propagations such as ground, space and sky wave propagations	CLO 13	T1: 22.1 to22.3 R1: 9.7 to 9.8
56-58	Differentiate space and surface waves, discuss about field strength variation with height and distance	CLO 14	T1:23.1 to 23.5, 24.2 to 24.14
59-60	Illustrate the concept of sky wave propagation and its parameters like MUF,CF,LUF, virtual height and skip distance, relation between MUF and skip distance	CLO 15	T1:25.1 to 25.6 R1: 10.7 to 10.9

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

S.No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Advanced communications.	Seminars / NPTEL	PO 1, PO 2	PSO 1
2	Design an antenna	Seminars / Guest Lectures / NPTEL	PO 2, PO 4	PSO 1

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