INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

(Approved by AICTE | NAAC Accreditation with 'A' Grade | Accredited by NBA | Affiliated to JNTUH)
Dundigal, Hyderabad - 500 043, Telangana

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**ANTENNAS AND WAVE PROPAGATION**			
Course Code	**A50418**			
Regulation	**R13 - JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	5	-	-	4
Course Coordinator	Mrs. A. Usha Rani, Associate Professor			
Team of Instructors	Mrs. A. Usha Rani, Associate Professor Mr.G. Nagendra Prasad Associate Professor, Mr. J. Siva RamaKrishna, Assistant Professor Mr. K. Ravi, Assistant Professor.			

I. COURSE OVERVIEW:

The course covers the basics of the antenna parameters, retarded potential, radiated power, radiation resistance, gain and directivity of thin linear wire antennas, VHF, UHF and microwave antennas like Yagi - Uda, Helical antenna, reflector antenna, micro strip antenna, and lens antenna, antenna arrays broadside and endfire, antenna measurements to measure the antenna parameters, wireless communication maintained through ground, space and sky.

II. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	5	Knowledge of basic electronic circuits

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam marks	Total marks
Midterm Test There shall be two midterm examinations. Each midterm examination consists of essay paper, objective paper and assignment. The essay paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of 20 minutes duration. It consists of 10 multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark.	75	100

First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem solving in nature with		

Sessional Marks	University End Exam marks	Total marks
critical thinking. Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

This course has the basics of antenna basics and types and concept of wireless communication through the various Medias. The main objectives of antennas and wave propagation are:

I. Understand the radiation phenomena associated with various types of antennas along with emphasis on their applications.
II. Analyze the basic antennas theory and apply them for radiation of electromagnetic fields
III. Demonstrate the concepts of radio wave propagation in the atmosphere.
IV. Employ the radiation mechanism to design different types of antennas.
V. To aware of the wave spectrum and respective band based antenna usage and also to know the propagation of the waves at different frequencies though layers in the existing layered free space environment structure.

VI. COURSE OUTCOMES:

At the end of the course the students are able to:

1. Aware of the parameter consideration viz. antenna efficiency, beam efficiency, radiation resistance ect. In the design of an antenna.
2. Capable of analyze the designed antenna and field evaluation under various conditions
3. Discover pattern multiplication principle for array antennas.

4. Formulate the electric as well as the magnetic fields equations set for far field and near field conditions.
5. Understand array system of different antenna and field analysis under application of different currents to the individual antenna elements.
6. Understand and design issues, operation of fundamental antennas like Yagi-Uda, Horn antennas and Helical structure and also their operation methodology in practice.
7. Design a lens structure and also the bench setup for antenna parameters measurement of testing for their effectiveness.
8. Design array antenna systems from specifications.
9. Determine directions of maximum signal radiations and the nulls in the radiation patterns
10. Identify the mechanism of the atmospheric effects
11. Knowledge about the means of propagation of Electromagnetic wave i.e. free space propagation and also about frequency dependent layer selection, its respective
12. Design issues for an effective transmission of information in the form of EM wave to a remote location and related issues.
13. To design the RF Antenna and Micro wave Antennas.
14. Able to analyze the Wave propagation in the Free space.
15. Understand the Polarizations of different types of Antennas.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	An ability to apply knowledge of mathematics, science and engineering fundamentals to the conceptualization of engineering models (**Fundamental Engineering Analysis Skills**).	S	Assignments, Exercises
PO2	An ability to design and conduct experiments, as well as analyze and interpret the data (**Information retrieval skills**).	H	Hands on Practice Sessions
PO3	An ability to design, implement and evaluate an electronics & communication engineering based system, component are process to meets desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability (**Creative Skills**).	S	Lab Sessions
PO4	An ability to function effectively as an individual and as a member or a leader in multidisciplinary teams (**Team Work**).	N	--
PO5	An ability to identify, formulate and apply appropriate techniques, resources and to solve complex electronics & communication engineering problems (**Engineering Problem Solving Skills**).	S	Design Exercises
PO6	An understanding of professional ethics and responsibilities of engineering practice (**Professional Integrity**).	N	--
PO7	An ability to communicate effectively on complex electronics and communication engineering activities with the engineering community and society at large such as writing effective reports and making effective presentations (**Communication Skills**).	N	--
PO8	Understanding of the impact of engineering solutions in a global, economic, environmental and societal context (**Engineering impact assessment skills**).	N	--
PO9	An ability to engage in life-long learning and an understanding of the need to keep current of the developments in the specific field of practice	S	Seminars Discussions

	(**Continuing education awareness**).		
PO10	Knowledge of contemporary issues like increased use of portable devices, rising health care costs and etc. which influence engineering design (**Social awareness**).	N	--
PO11	An ability to use current techniques, skills and modern engineering tools necessary to analyze electronics &communication engineering practice (**Practical engineering analysis skills**).	H	Design Exercises, Seminars, Paper Presentations
PO12	An ability to apply creativity in design and development of electronic circuits, equipment, components, sub-systems and systems (**Software and Hardware Interface**).	S	Design Exercises, Development of Prototypes, Mini Projects
PO13	An ability to recognize the importance of professional developments by pursuing post graduate studies or facing competitive examinations that offer challenging and rewarding careers in designing (**Successful Career and Immediate Employment**).	H	Exams, Discussions

N - None S - Supportive H - Highly Related

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**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.	H	Lectures, Assignments
PSO2	**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.	S	Projects
PSO3	**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 Entreprene.	S	Guest Lectures

N - None S - Supportive H - Highly Related

IX. SYLLABUS:

UNIT I

Antenna Basics: Introduction, Basic Antenna Parameters-Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity-Gain-Resolution, Antenna Apertures, Effective Height, illustrative Problems, Fields from Oscillating Dipole, Field Zones, Front-to-Back Ratio, Antenna Theorems, Radiation, Retarded Potentials-Helmholtz Theorem **Thin Linear Wire Antennas:** Radiation from Small Electric Dipole, Quarter Wave Monopole and Half Wave Dipole, Current Distributions, Field Components, Radiated Power, Radiation Resistance, Beam width, Directivity,
,Effective Area and Effective Height, Natural Current Distributions, Far Fields and Patterns of Thin Linear Centre-fed Antennas of Different Lengths, Illustrative Problems, Loop Antennas- Introduction, Small Loop, Comparison of Far Fields of Small Loop and Short Dipole, Radiation Resistances and Directivities of Small and Large Loops(Quantitative Treatment)

UNIT II

VHF,UHF and Microwave Antennas-I: Arrays with Parasitic Elements, Yagi-Uda Array, Folded Dipoles and their Characteristics, Helical Antennas-Helical Geometry, Helix modes, Practical Design Considerations for MonofilarHelical Antenna in Axial and Normal Modes, Horn Antennas- Types, Fermat's Principle, Optimum Horns, Design
Considerations of Pyramidal Horns, Illustrative Problems.

UNIT III

VHF, UHF and Microwave Antennas- II : Microstrip Antennas-Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas- Geometry and Parameters, Characteristics of Microstrip Antennas, Impact of Different parameters on Characteristics, Reflector Antennas- Introduction, Flat Sheet and Corner Reflectors, Paraboloidal Reflectors- Geometry, Pattern Characteristics, Feed Methods, Reflector types- Related Features, Illustrative Problems
Lens Antennas: Introduction, Geometry of Non-metallic Dielectric Lenses Zoning, Tolerances, Applications

UNIT IV

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, 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 (by Comparison, Absolute and 3-Antenna Methods)

UNIT V

Wave Propagation - I: Introduction, Definitions, Categorizations and General Classifications Different Modes of Wave Propagation, Ray/Mode Concepts, Ground Wave Propagation (Qualitative Treatment)-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 and 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.

TEXTBOOKS:

1. Antennas and Wave Propagation – J.D. Kraus, R.J. Marhefka and Ahmad S. Khan, TMH, New Delhi, 4th ed., (Special Indian Edition) 2010.
2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd ed., 2000

REFERENCES:

1. Antenna Theory – C.A. Balanis, John Wiley & Sons, #rd ed., 2005.
2. Antennas and Wave Propagation – K.D. Prasad, Satya Prakashan, Tech Indian Publications, New Delhi, 2001.
3. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont, The Services Text Book of Radio, Vol. 5, Standard Publishers Distributors, Delhi.
4. Electronic and Radio Engineering – F.E. Terman, McGraw-Hill, 4th edition, 1955.
5. Antennas – John D.kraus, McGraw-Hill (International Edition), 2nd ed. 1988.

XI. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes.

Lecture No.	Learning Objective	Course Learning Outcomes	Reference
1	Introduction to Antenna	Introduction, Basic Antenna Parameters	**T1:R2**
2	To learn the basic parameters	Patterns, Beam Area, Radiation Intensity	**T1:R2**
3	To learn the basic parameters	Beam Efficiency,Directivity, Gain, Resolution	**T1:R2**
4	To learn about basic parameters	Antenna Apertures, Effective Height	**T1:R2**
5	Introduction to Dipoles	Fields from Oscillating Dipole, Field Zones	**T1:R2**
6	To learn about basic Maxwell's Theorems	Antenna Theorems, Radiation	**T1:R2**
7	To learn about basic Maxwell's Theorems	Retarded Potentials- Helmholtz Theorem	**T1:R2**
8	To learn about Wire antennas	**Thin Linear Wire Antennas** Radiation from Small Electric Dipole	**T1:T2**
9	To learn about wave dipole	Quarter Wave Monopole and Half Wave Dipole	**T1:T2**
10	Introduction to Nature of	Current Distributions, Field Components	**T1:T2**

	Fields		
11	To learn about	Radiated Power, Radiation Resistance	**T1:T2**
	power and Resistance		
12	To learn about Beam width	Beam width, Directivity,	**T1:T2**
13	To learn about Effective area	Effective Area and Effective Height	**T1:T2**
14	To learn about parameters of natural current	Natural Current Distributions	**T1:T2**
15	To learn about parameters of different field pattern	Far Fields and Patterns of Thin Linear Centre-fed Antennas of Different Lengths	**T1:T2**
16	Related Problems	Illustrative Problems, Loop Antennas-Introduction, Small Loop	**T1:T2**
17	To learn about Different loops	Comparison of Far Fields of Small Loop and Short Dipole	**T1:T2**
18	To learn about Different loops	Radiation Resistances and Directivities of Small and Large Loops(Quantitative Treatment)	**T1:T2**
19	Related Problems.	Revision	**T1:T2**
20	To learn about Different Frequencies of antennas	**VHF, UHF and Microwave Antennas-1** Arrays with Parasitic Elements, Yagi-Uda Array	**T1:R5**
21	Learn about dipoles	Folded Dipoles and their Characteristics	**T1:R5**
22	Learn about Different antennas	Helical Antennas-Helical Geometry, Helix modes, Practical Design Considerations for Monofilar Helical Antenna in Axial and Normal Modes	**T1:R5**
23	Learn about Different antennas	Horn Antennas- Types, Fermat's Principle, Optimum Horns, Design Considerations of Pyramidal Horns, Illustrative Problems	**T1:R5**
24	Related Problems.	Revision	**T1:R5**
25		**VHF, UHF and Microwave Antennas-II**	

	To learn about Different Frequencies of antennas	Microstrip Antennas-Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas- Geometry and Parameters,	**T1:R5**
26	Learn about antennas characteristics	Characteristics of Microstrip Antennas Impact of Different parameters on Characteristics	**T1:R5**
27	Learn about Reflector antennas characteristics	Reflector Antennas- Introduction, Flat Sheet and Corner Reflectors	**T1:R5**
28	Learn about Reflector antennas characteristics	Paraboloidal Reflectors- Geometry	**T1:R5**
29	Learn about antennas characteristics	Pattern Characteristics, Feed Methods,	**T1:R5**
30	Learn about Different of reflector	Reflector types- Related Features	**T1:R5**
31	Related Problems.	Illustrative Problems	**T1:R5**
32	Learn about Lens antennas	**Lens Antennas:** Introduction, Geometry of Non-metallic Dielectric Lenses	**T1:R5**
33	Learn about Zoning	Zoning, Tolerances, Applications	**T1:R5**
34	Related Problems.	Revision	**T1:R5**
35	Learn about Arrays	**Antenna Arrays:** Point Sources- Definition, Patterns	**T1:R1**
36	Learn about Isotropic antennas	Arrays of 2 Isotropic Sources – Different Cases	**T1:R1**
37	Derivation of Multiplication pattern	Principle of Pattern Multiplication	**T1:R1**
38	Learn about types of Linear arrays	Uniform Linear Arrays- Broadside Arrays, End-fire Arrays, EFA with Increased Directivity	**T1:R1**
39	Learn about characteristics of	Derivation of their Characteristics and Comparison,	**T1:R1**

	arrays		
40	Learn about Distributions	BSAs with Non-Uniform Amplitude Distributions	**T1:R1**
41	Learn about arrays and Related Problems.	General considerations and Binomial Arrays, Illustrative Problems	**T1:R1**
42	Introduction to antennas measurement	**Antenna Measurement:** Introduction, Concepts-Reciprocity	**T1:R2**
43	Introduction to fields	Near and Far Fields, Coordinate System, Sources of errors	**T1:R2**
44	Learn about pattern measurement	Pattern to be Measured, Pattern Measurement Arrangement	**T1:R2**
45	Learn about antenna parameter measurement	Directivity Measurement, Gain Measurement (by Comparison, absolute and 3-Antenna Methods)	**T1:R2**
46	Solving Related Problems	Revision	**T1:R2**
47	Introduction to wave propagation	**Wave Propagation-I** Introduction, Definitions, Categorizations and General Classifications	**T1:R2**
48	Learn about different modes of propagation	Different Modes of Wave Propagation	**T1:R2**
49	Learn about Basic Modes	Ray/Mode Concepts.	**T1:R2**
50	Learn about propagation waves	Ground Wave Propagation (Qualitative Treatment)- Introduction, Plane Earth Reflections, Space and Surface Waves	**T1:R2**
51	Learn about reflection	Wave Tilt, Curved Earth Reflections	**T1:R2**
52	Learn about space propagation	Space Wave Propagation- Introduction, Field Strength Variation with Distance and Height,	**T1:R2**
53	To Learn about curvature effect	Effect of Earth's Curvature, Absorption	**T1:R2**
54	To Learn about various types of propagation and refraction	Super Refraction, M-Curves and Duct Propagation, Scattering Phenomena	**T1:R2**

55	To Learn about various types of propagation	Tropospheric Propagation	**T1:R2**
56	To Learn about various types of sky wave by ionosphere	**Wave Propagation-II** Sky Wave Propagation- Introduction, Structure of Ionosphere, Refraction and Reflection of Sky Waves by Ionosphere	**T1:R2**
57	To Learn about types frequency in propagation	Ray Path, Critical Frequency, MUF, LUF, OF, Virtual Height and Skip Distance	**T1:R2**
58	To Learn about types frequency in propagation	Relation between MUF and Skip Distance	**T1:R2**
59	To Learn about types frequency in propagation	Multi-hop Propagation	**T1:R2**
60	Related Problems.	Revision	**T1:R2**

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

Course Objectives	Program Outcomes													Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PO 13	PSO 1	PSO 2	PSO 3
I	S	H			S				S		H	S	H	H	S	
II	S	H												H	S	
III	S				S						H	S	H	S	H	
IV		H	S											H	S	
V			S											H		S
VI	S				S									H	S	S

S - Supportive **H - Highly Related**

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

Course Outcomes	Program Outcomes													Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
1	S	H									H	S		H	S	
2	S		S						S					S	H	
3		H	S		S								H	H	S	
4			S											S	H	
5		S							S					S	H	
6		H									H			H	S	
7	S				S				S				H	S	H	
8	S	H										S		H	S	
9	S	H										S		S	H	
10	H			S										S	H	S
11		H		S				S							H	
12		S		S										H		
13											H					
14	S		S	H				H			S				S	
15			S			H									S	

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