COURSE FILE

Subject: **ANTENNAS AND WAVE PROPOGATION**

Year: **III– B.Tech, II SEM** Branch: **ECE**

CONTENTS

1. **DEPARTMENT VISION & MISSION**

VISION OF THE DEPARTMENT

To promote excellence in technical education and scientific research in electronics and communication engineering for the benefit of society.

2. **MISSION OF THE DEPARTMENT**

M1: To impart excellent technical education with state of art facilities inculcating values and lifelong learning attitude.

M2: To develop core competence in our students imbibing professional ethics and team spirit.

M3: To encourage research benefiting society through higher learning.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Establish themselves as successful professionals in their career and higher education in the field of Electronics & Communication Engineering and allied domains through rigorous quality education.

PEO 2: Develop Professionalism, Ethical values, Excellent Leadership qualities, Communication Skills and teamwork in their Professional front and adapt to current trends by engaging in lifelong learning

PEO 3: Apply the acquired knowledge & skills to develop novel technology and products for solving real life problems those are economically feasible and socially relevant

PEO 4: To prepare the graduates for developing administrative acumen, to adapt diversified and multidisciplinary platforms to compete globally

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Ability to apply concepts of Electronics & Communication Engineering to associated research areas of electronics, communication, signal processing, VLSI, embedded systems, IoT and allied technologies.

PSO2: Ability to design, analyze and simulate a variety of Electronics & Communication functional elements using hardware and software tools along with analytic skills.

Program Outcomes (POs) :

PO1:Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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.

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.

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.

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.

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.

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.

PO8:Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9:Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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.

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.

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.

2.Course outcomes & Course Outcome (CO)-Program Outcome (PO) Matrix:

CO 1	Aware of different parameters and their consideration in design viz. antenna beam , its efficiency ,radiation efficiency etc… and capable of analyse the designed antenna and its field evaluations and various conditions
CO 2	Understand the array system of different antennas and field analysis under application of different currents to individual antenna elements
CO 3	Understand the design issues, operation of fundamental antennas like Yagi-Uda and their operation methodology.
CO 4	Understand the design issues, operation of advanced antennas like Micro strip and lens antennas and their operation methodology
CO 5	Knowledge about the means of propagation of electromagnetic wave and also frequency dependent layer selection, the issues present in the transmission

CO's/ PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	2	-	-	2	2	3	-
CO2	-	2	2	-	2	2	-	-	-	-	-	-
CO3	3	2	2	2	2	2	-	-	2	-	-	-
CO4	2	3	2	-	2	2	-	-	2	2	-	-
CO5	3	2	3	-	-	2	-	-	2	2	-	-

Course Outcome (CO)-Program Specific Outcome (PSO) Matrix:

CO's/	PSO1	PSO2
C321.1	2	-
C321.2	2	2
C321.3	2	2
C321.4	3	2
C321.5	3	3
C321.6	2	2
AVG	2	2

4. SYLLABUS

UNIT:1

Antenna basics: introduction, basic antenna parameters-patterns, beam area, radiation intensity, beam efficiency, directivity/gain resolution, antenna aperture, effective height, illustrative problems. Fields from oscillating dipole, field zones, shape: impedance considerations, antenna temperature, front to back ratio, antenna theroms, radiation: basic max well equations retarded potentials: Helmholtz theorem.

Thin linear wire antennas- radiation from small electric dipole, quarter wave monopole and half wave dipole-current distributions, field comparisons, 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, comparision of far fields of small loop and short dipole, radiation resistance and directives of small and large loops(qualitative treatment)

UNIT:II

Antenna arrays: Point Sources- Definition, Patterns, arrays of 2 Isotropic Sources Different Cases, Principle of patterns Multiplication, uniform Liners 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 Binomials Arrays, IIIustrative problems.

Antenna measurements: introduction, concepts-reciprocity, near and far fields, coordinate system.

UNIT:III

VHF, UHF, MICROWAVE ANTENNAS:1-

Arrays with parasitic elements, yagi-uda array, folded dipoles and their characteristics, helical antennas-helical geometry, helix modes, practical design considerations for monofilar helical antenna in axial and normal modes. Horn antennas-types,fermat’s principal, optimum horns, design considerations of pyramidal horns, illustrative problems.

UNIT:IV-VHF, UHF, MICROWAVE ANTENNA-ii-

Micro strip antennas-introduction, features, adv and limitations, rectangular patch antennas-geometry and parameters, characteristics of micro strip antennas. Impact of different parameters on characteristics, reflector antenna-introduction, flat sheet and corner reflectors, parabolic reflector-geometry ,pattern characteristics, feed methods, reflector types-related features, illustrative problems.

UNIT:V

Wave propagation1: Introduction, definitions, categorization 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, troposphere propagation, fading and path loss calculations.

Wave propagationII: Sky wave propagation-introduction, structure of ionosphere, refraction and reflection of sky wave by ionosphere, ray path, critical frequency, MUF,LUF,OF,Virtual height and skip distance, relation between MUF,and skip distance, multichop propagation, energy loss in ionosphere, summary of wave characteristics in different frequency ranges

SUGGESTED BOOKS

TEXT BOOKS

T1. Antennas and wave propagation-J.D.kraus, R.J.Marhefka and Ahmad S.khan, TMH, New Delhi, 4th edition,(special indian edition) 2010.

T2.Electromagnetic wave and radiating systems-E.C.Jordan and k.g.balmann,phi,2nd ,edition 2000.

REFERENCE BOOKS

R1. Antenna Theory-C.A.Balanis, Johnwiley And Sons, 3rd , Edition,2005.

R2.Antenna And Wave Propagation-K.D.Prasad,SatyaPrakashan Tech India Publications, New Delhi ,2001.

R3. Transmission and propagation-E.V.D Glazier and H.R.L...Lamont, the services text book of radio, vol 5, standard

R4. Electronic and radio engineering-F.E.Terman,MCGraw-hill,4th edition,1955.

R5. Antennes-John d.kraus, MC Graw-Hill(international édition) 2nd édition 1988,

5. INDIVIDUAL TIME TABLE SUBJECT: AWP III-ECE D, ECAD LAB III-ECE D

Day & Time	I 09.10 – 10.10	II 10.10 – 11.00	III 11.00 – 11.50	IV 11.50 – 12.40	12.40 - 01.20	V 01.20 – 02.20	VI 02.20 – 03.10	VII 03.10 – 04.00
MON	SEC-D						SEC-A	
TUE		SEC-A			L			
WED					U	ECAD LAB-D		
THU	SEC-D		SEC-D		N	ECAD LAB-D		
FRI				SEC-A	C			SEC-D
SAT		SEC-D			H	SEC-A		

6. Session Plan

Unit No	Unit Title	No. of hours Required
Unit 1	Antenna basics	14
Unit 2	Antenna arrays	12
Unit 3	VHF, UHF, MICROWAVE ANTENNAS:I	9
Unit 4	VHF, UHF, MICROWAVE ANTENNA-II	12
Unit 5	Wave propagation	13

7. Session execution log

S.NO	TOPIC TO BE COVERED	Suggested Books (Eg. T1, T2,R5)	NO. OF LECTURES REQUIRED	Remarks
	UNIT - I			**No.of periods required= 14**
1.	Antenna basics: introduction, basic antenna parameters-patterns, beam area,	T1,T2,R2,R4	L1	
2.	Radiation Intensity, Beam Efficiency, Directivity/Gain Resolution,	T1,T2,R2,R4	L2	
3.	Antenna aperture, effective height,. Fields from oscillating dipole, field zones, shape: impedance	T1,T2,R2,R4	L3	
4.	Considerations, antenna temperature, front to back ratio,	T1,T2,R2,R4	L4	
5	Antenna Theroms,Radiation:Basic Max Well Equations	T1,T2,R2,R4	L5	
6	Retardedpotentials:helmholtz theorem.	T1,T2,R2,R4	L6	
7	Illustrative Problems	T1,T2,R2,R4	L7	
9	Thin linear wire antennas-radiation from small electric dipole	T1,T2,R2,R4	L8	
10	Quarter wave monopole	T1,T2,R2,R4	L9	
11	half wave dipole-current distributions	T1,T2,R2,R4	L10	
12	Field comparisons	T1,T2,R2,R4	L10	
13	Radiated power, radiation resistance	T1,T2,R2,R4	L11	
14	Beam width, directivity, effective area	T1,T2,R2,R4	L11	
15	effective height, natural current distributions	T1,T2,R2,R4	L11	
16	Far fields and patterns of thin linear centre fed antennas of different lengths	T1,T2,R2,R4	L12	
17	Loop antennas-introduction	T1,T2,R2,R4	L12	
18	Small loop,comparision of far fields of small loop and short dipole	T1,T2,R2,R4	L13	
19	Radiation resistance and directives of small and large	T1,T2,R2,R4	L13	

	loops(qualitative treatment			
20	Illustrative problems	T1,T2,R2,R4	L14	
	UNIT-II			**No.of periods required=12**
21	Antenna arrays: Point Sources-Definition, Patterns	T1,T2,R2,R4	L16	
22	Arrays of 2 Isotropic Sources Different Cases	T1,T2,R2,R4	L17	
23	Principle of patterns Multiplication,	T1,T2,R2,R4	L18	
24	uniform Liners Arrays – Broadside Arrays	T1,T2,R2,R4	L19	
25	End fire Arrays	T1,T2,R2,R4	L20	
26	EFA with Increased Directivity	T1,T2,R2,R4	L21	
27	Derivation of their Characteristics and Comparison	T1,T2,R2,R4	L22	
28	BSAs with Non-uniform Amplitude	T1,T2,R2,R4	L23	
29	Distributions-General Considerations and Binomials Arrays.	T1,T2,R2,R4	L24	
30	illustrative problems	T1,T2,R2,R4	L25,L26	
	UNIT-III			**No.of periods required= 9**
31	VHF,UHF,MICROWAVE ANTENNAS:1- arrays with parasitic elements	T1,T2,R2,R4	L27	
32	Yagi-udaarray,folded dipoles and their characteristics	T1,T2,R2,R4	L28	
33	helical antennas-helical geometry,	T1,T2,R2,R4	L29	
34	Helix modes	T1,T2,R2,R4	L30	
35	Practical design considerations for monofilar helical antenna in axial and normal modes.	T1,T2,R2,R4	L31	
36	Hornantennas-types,fermat's principal,	T1,T2,R2,R4	L32	
37	Optimum horns, design considerations of pyramidal horns,	T1,T2,R2,R4	L33	
38	Illustrative problems.	T1,T2,R2,R4	L34,L35	
	UNIT-IV			**No.of periods required= 12**

39	VHF,UHF,MICROWAVE ANTENNA-ii- micro strip antennas-introduction	T1,T2,R2,R4	L36	
40	Features, adv and limitations, rectangular patch	T1,T2,R2,R4	L37	
41	Antennas-geometry and parameters, characteristics of micro strip antennas	T1,T2,R2,R4	L38	
42	impact of different parameters on characteristics,	T1,T2,R2,R4	L39	
43	Reflector antenna-introduction,flat sheet and corner reflectors	T1,T2,R2,R4	L40	
44	paraboliccreflector-geometry,pattern characteristics	T1,T2,R2,R4	L41	
45	Feed methods, reflector types-related features	T1,T2,R2,R4	L41	
46	Illustrative problems	T1,T2,R2,R4	L42	
47	Lens antennas- introduction, geometry of non-metallic dielectric lenses	T1,T2,R2,R4	L43	
48	Zoning,tolerances,applications.	T1,T2,R2,R4	L44	
49	Antenna measurements: introduction, concepts-reciprocity,near and far fields	T1,T2,R2,R4	L45	
50	Coordinate system, source of errors	T1,T2,R2,R4	L45	
51	Patterns to be measured, pattern measurement arrangement	T1,T2,R2,R4	L46	
52	Directivity measurement	T1,T2,R2,R4	L46	
53	Gain measurement(by comparision, absolute and 3-antenna methods.)	T1,T2,R2,R4	L47	
54	Illustrative Problems	T1,T2,R2,R4	L47	
	UNIT-V			**No.of periods required= 8**
55	Introduction, definitions, categorization and general classifications	T1, R2,R4	L48	
56	Different modes of wave propagation , Ray/mode concepts	T1,R2,R4	L49	
57	Ground wave propagation (qualitative treatment)-introduction, plane earth reflections,	T1, R2,R4	L50	

58	Space and surface waves, wave tilt, curved earth reflections	T1, R2,R4	L51	
59	space wave propagation-introduction, field strength variation with distance and height	T1, R2,R4	L52	
60	Effect of earth's curvature, absorption.	T1, R2,R4	L53	
61	Super refraction, m-curves and duct propagation	T1, R2,R4	L54	
62	scattering phenomena, troposphere propagation, fading and path loss calculations	T1, R2,R4	L55	
	UNIT-V-PART:2			**No.of periods required= 5**
63	Sky wave propagation-introduction	T1, R2,R4	L56	
64	Structure of ionosphere, refraction and reflection of sky wave by ionosphere	T1, R2,R4	L57	
65	Ray path, critical frequency, MUF, LUF, OF, frequency ranges.	T1, R2,R4	L58	
66	height and skip distance, Relation between MUF, and skip distance	T1, R2,R4	L59	
67	Multihop propagation, Energy loss in ionosphere, summary of wave characteristics in different1	T1, R2,R4	L60	
			Total Classes	56

8.METHODS OF TEACHING:

M1 : Lecture Method	**M6 : Tutorial**
M2 : Demo Method	**M7 : Assignment**
M3 : Guest Lecture	**M8 : Industry Visit**
M4 : Presentation /PPT	**M9 : Project Based**
M5 : Lab/Practical	**M10 : Charts / OHP**

9. . Sample assignment script

(Attached separately)

10.ASSIGNMENT QUESTIONS -MID-1

SET-1

1. a) Define an Antenna parameters.
   i. Pattern ii. Beam Area iii. Directivity iv. Aperture area v. Effective height (CO1)
2. Compare small loop antenna with short dipole with respect to following parameters
   E-field, H-field, Radiation resistance. (CO1)
3. Give the statements various antenna theorems. (CO1)
4. Define various mode of helical antenna. (CO2)
5. Discuss design consideration of Horn antenna (CO2)

set-2

1. Define following with appropriate expressions and figures. (CO1)
   a) Pattern b) beam area c) radiation intensity d) antenna aperture e) directivity
2. Explain field zones in antenna. (CO1)
3. Draw far field pattern and current distribution of thin wire antenna of various length.(CO1)
4. Compare small loop antenna with short dipole antenna w.r.t following parameters
   E-field component, H-field component. (CO1)
5. Mention all the optimum design parameters of rectangular and conical horn antennas (CO2)

set-3

1. Explain formation of fields from an oscillating dipole.(CO1)
2. Draw the far field pattern and current distribution of a thin linear wire antenna of various lengths (CO1).
3. Far field equations and radiation resistance of $\lambda/2$ antenna (CO1)
4. a)Define axial ratio with its significance. (CO4)
   b) Define helical antenna with its characteristics and applications.(CO2)
5. Define an Antenna parameters.
   i. Pattern ii. Beam Area iii. Directivity iv. Aperture area v. Effective height (CO1)

MID-II ASSIGNMENT QUESTIONS

Set :1

1. Mention the frequency ranges of operation and applications of (CO2)
   i) Loop antenna ii) Helical antenna iii) Lens antenna
2. Explain the n- array source with equal amplitude and same phase (CO4)
3. Explain the effect of the following on troposphere wave propagation?(CO5)
   (a) radius of curvature of path (b) Earths radius (c) Earths curvature
4. Explain about following terms (CO5)
   i) Maximum of MUF ii) Optimum frequency
5. With a neat sketch explain the image formation for the case of 45^{o} corner reflector (CO3)

Set :2

1. With neat sketch explain basic set up and requirements, for antenna pattern measurement (CO4)
2. Explain the n- array source with equal amplitude and different phase (CO4)
3. Explain the effect of atmosphere on space wave propagation?(CO5)
4. Write a short note on
i). D-layer, ii) Sporadic E-layer, iii) Fading and iv). Atmospheric noise (CO5)
5. What is meant by critical frequency? Describe a method to measure it. (CO5)

Set :3

1. With a neat sketch explain the image formation for the case of 90^{o} corner reflector (CO3)
2. What is an antenna array? Explain its classification? (CO4)
3. Write short note on the following(CO5)
   i). M curves and their characteristics
   ii). Troposcatter propagation of electromagnetic waves
4. Distinguish between the terms MUF, LUHF, and Optimum frequency (CO5)
5. Describe the salient features of multi hop propagation (CO6)

11. Unit-wise course material

Provided separately

12. Descriptive Test Question Papers

Attached separately

13. Sample mid answer script

Attached separately

14. Material collected from Internet/Websites

AWp notes.zip

15. Power point presentations

Awp.zip

16.Innovation teaching methods (if any)

Attached separately

17. PREVIOUS EXAMINATION QUESTIONS UNIT WISE

UNIT:1

1. Mention the frequency ranges of operation and applications of

i) Loop antenna

ii) Helical antenna

iii) Lens antenna.

2. Derive the EMF equation for a small loop antenna.

3. Explain radiation from a quarter wave monopole with sketches.

4. Explain radiation from a quarter wave monopole with sketches.

5.Prove that for a Hertizian dipole, the aperture area is 0.122λ and for a half wave dipole, it is 0.132λ and for an isotropic radiator, it is 0.082λ. Explain relations used.

6. Explain radiation from a quarter wave monopole with sketches.

7. Draw the radiation pattern of an dipole Antenna and explain all its characteristics?

8. Find the radiation resistance and directivity of a circular loop antenna of 20 cm. diameter at a frequency of 100 MHz what happens

i) if the loop is changed in to a square loop of same area.

ii) ii) If the no. of turns of the circular loop is doubled.

9. What is an elementary doublet? How does it differ from the infinitesimal dipole?

10. 10m high monopole is to be used as a portable transmitting antenna at 1.5MHz. Its measured base reactance is j350 ohms with Q=100 and ohmic losses in the ground system and turning cost are equal. Find antenna efficiency, gain of the antenna and its aperture.

11. Discuss the conditions under which parasitic dipole placed near and parallel to a driven dipole can act as reector?

12. A Hertzian dipole of length dl=0.5m is radiating into free space. If the dipole current is 4A and the frequency is 10MHz, calculate the highest power density at a distance of 2km from the antenna.

13.Find the field pattern of loop antenna using principle of arrays.

14. Determine magnitude of E and H of a half wave dipole operated at a of frequency of 300 MHz at a distance of 100m in the broad side plane for maximum radiation. Input current to antenna is 100mA. How much average power is radiated by this antenna?

15. Define

i. Radial power flow

ii. Radiation resistance for a short dipole

iii. Uniform current distribution

16.What are the advantages and disadvantages of loop antennas?

17Sketch and compare radiation patterns of horizontal half wave dipole with those of vertical half wave Dipole

18. Derive the relationship between directivity and effective area, directivity and effective length.

19. Define

1) Radiation Intensity, ii) Beam Area, iii) Effective Height and iv) Resolution

20. Define and explain Directivity and Power Gain of an Antenna. Prove that the directivity of a halfwave dipole is 2.15dB.

21. What are principle planes? How the Antenna Beam Width is defined in such planes

22. Define and explain the following terms.

i). Gain ii).Directivity iii). Radiation Resistance iv). Bandwidth

23. Define the following terms:

i) Gain. ii) Directivity iii) Radiation resistance iv)Effectivearea.

24. Derive the relationship between Directive Gain, Radiation Resistance and Effective Length.

25. Define the terms electrostatic field, induction field, and radiation field of an antenna and bring out their significance

UNIT-2

1. Draw the general structure and radiation pattern of travelling wave antenna and give expression for its electric field strength.

2. Explain how unidirectional pattern is obtained using a properly terminated rhombic antenna?
3. While measuring gain of a horn antenna ,the oscillator was set at 9GHz frequency and the attenuation inserted was 9.8dB.Calculate the gain of the horn antenna if the distance between the two horns is 35cm?
4. What is meant by antenna coupling. Derive condition for same.
5. The pyramidal horn is required to have a half power width of 100 in both the vertical and horizontal planes. Determine the dimensions of the horn mouth and the length of the horn in wavelengths, and the directive gain?
6. With neat sketch explain the operation of H-plane horn antenna?
7. Explain travelling wave antenna and draw its radiation pattern.
8. Draw the structure and Explain the principle of working of helical antenna in normal mode.

9.Discuss the characteristics of an optimum horn. Calculate its gain and directivity, when the aperture dimensions are 30cm × 41.1cm at 10GHz.

11. what is optimum spacing used in parasitic array? Why
12. Determine the lengths and spacing requirements for a three element YAGI UDA antenna at500MHz
13. Distinguish between sectorial, pyramidal, and conical horns with sketches. List their applications.
14. Explain in detail the constructional features of helical antenna
15. with a neat diagram describe the principle of working of a three element Yagi-uda antenna.
16. what is the principle of equality of path length? How is it applicable to horn antenna? Obtain an expression for the directivity of pyramidal horn in terms of its aperture dimensions
17. Briefly explain the impedance measurement of a horn antenna by using slotted line method.

UNIT:3

1. Compare the performances of different reflectors?
2. Write the design relations associated with Rhombic antenna. What are its applications?
3. with a neat sketch explain the image formation for the case of 45o corner reflector
4. Write short notes on diffraction effects in plane sheet reflectors
5. Describe the construction and properties of rhombic antenna.

6. What are the advantages of rhombic antenna over single wire antennas
7. Write short notes on Diffraction effects in plane sheet reflectors
8. Evaluate the power gain directing and the required diameter of a paraboloid having a null beam
   width of 10 degrees at 3 GHz
9. Explain the gain and beam width relations for a parabolic reflector and account for its beam shaping considerations.

UNIT:4

1. Explain the characteristics and properties of a Broad side array.
2. An array consists of four identical isotropic sources located at corners of a square having diagonal length 3_=4 and excited with equal current in same phase. Determine the polar diagram of the array in the plane containing the sources.
3. Why practically Isotropic radiator can not exist?
4. What are the advantages and disadvantages of binomial array
5. list out the design relations associated with a rhombic antenna. What are its applications?
6. what is a uniform linear array and what are its applications
7. Derive the conditions for the linear array of 'N' isotropic elements to radiate in end-fire and broadside mode and find the first two side lobe levels
8. What are the various differences between end-fire and broadside arrays
9. Explain the principle of multiplication of patterns?
10. Find the radiation pattern for four isotropic elements fed in face, spaced λ/2 apart by using pattern
    Multiplication
    LOOP antennas
11. Show that the peaks of the array factor of an N-element uniform array are given by the solution of the equation N tan(ψ/2)= Tan (Nψ/2)
12. A uniform linear array consists 16 isotropic point sources with a spacing of λ/4. If the phase diffrence is 900, calculate
    i. HPBW,
    ii. Directivity
    iii. Beam Solid Angle
    iv. Effective Aperture
13. Derive the condition for directivity of end fire array with increased directivity

14. For a broad cast antenna of 20m height at 750KHz.Claculate the expressions of far fields E and H and radiation resistance for an input excitation of 1mA current.
15. Prove that the directivity can be improved by using a number of antennas in any broad side or end fire array
16. Differentiate between binomial and uniform broad side arrays.
17. How a unidirectional pattern is obtained in an end fire array. Explain?
18. Which primary feed used for the lens antenna?Why?
19. Mention the frequency ranges of operation and applications of
i) Loop antenna
ii) Helical antenna
iii) Lens antenna
20. With neat sketch explain basic set up and requirements, for antenna pattern measurement
21. how is the field pattern of the "Receiving Antenna" experimentally determined? Explain it with a neat block diagram
22. What are the precautions to be taken while conducting antenna pattern measurements
23.Explain the gain measurement of an antenna by comparison method.
24. Define and explain Directivity and Power Gain of an Antenna. Prove that the directivity of a half wave dipole is 2.15dB.
25. with a neat sketch explain the absolute method of measuring the gain of an antenna
26. Explain the significance, merits and demerits of zoning in lens antennas

UNIT:5

1. Explain the effect of the following on tropospheric wave propagation?
(a) radius of curvature of path
(b) Earths radius
(c) Earths curvature.
2.Write a short notes on
i). D-layer, ii) Sporadic E-layer, iii) Fading and iv). Atmospheric noise
1. Explain the efect of atmosphere on space wave propagation?
2. calculate the maximum wqvelength at which propagation is possible by means of a grounded based duct of 100ft high when$\Delta M=25$.
3. With neat sketch explain basic set up and requirements, for antenna pattern measurement.
4. Discuss the significance and requirement for polarization in surface wave propagation.
5. Discuss about the following

a) Duct formation and its significance

b) Shadow zone

c) Effective earth's radius

d) Free space path lodes

7. what is LOS propagation? Under what conditions it can exist

8. Explain the formation of inversion layer in the troposphere in the phenomenon of duct propagation

9. Establish the mathematical relations for

i). adio horizon and ii). Radius of curvature of array path for LOS waves

10. Write short note on the following

i). M curves and their characteristics

ii). Troposcatter propagation of electromagnetic waves

11.Discuss the importance of ground wave propagation for communication

12. What is wave tilt and how does it affect the field strength received at a distance from the transmitter.

13. Describe a method of estimating the height of ionospheric layer?

14. Write short notes on sun spot cycle?

15. Two points on the earth are 1600Km apart and are communicated by means of HF communication .For single hop transmission ,the critical frequency at that time is 7.3MHz.calculate MUF for these two points if the height of the ionospheric layer is 300Km?

16. Write about the following :

(a) ionospheric abnormalities.

(b) formation of ionospheric layer

17. Explain about following terms

i) Maximum of MUF

ii) Optimum frequency

18.What is meant by critical frequency? Describe a method to measure it

19. Explain the effects of D-layer in sky wave propagation

20. Distinguish between the terms MUF, LUHF, and Optimum frequency

21. Write a short notes on

i). Ionosphere abnormalities

ii). Optimum working frequency and LUHF

22.Describe the fading of short wave broadcast signals

23. Describe the salient features of multi hop propagation

81. References (Text books/websites/Journals)

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JOURNALS

1. IEEE TRANSACTIONS ON ANTENNAS
2. IEEE PROCEEDINGS ON COMMUNICATIONS.
3. INTERNATIONAL JOURNAL OF ANTENNA WAVE PROPAGATION.