

PROPAGATION AND ANTENNA

ENEX 303

Lecture : 3
Tutorial : 1
Practical : 3/2

Year : III
Part : I

Course Objectives:

The objective of this course is to provide a comprehensive understanding of electromagnetic wave propagation and the working principles of various types of antennas. It emphasizes their characteristics, design considerations, and applications in modern communication systems.

1 Introduction (6 hours)

- 1.1 Radiation phenomena in a conductor
- 1.2 Function of antenna
- 1.3 Retarded potentials: EM wave generation and propagation
- 1.4 Radiated electric and magnetic fields in EM wave
- 1.5 Radiation patterns and input impedance of very short dipole, short dipole and long dipoles
- 1.6 Antenna theorems
 - 1.6.1 Reciprocity theorem
 - 1.6.2 Superposition theorem
 - 1.6.3 Thevenin theorem
 - 1.6.4 Maximum power transfer theorem
 - 1.6.5 Compensation theorem
 - 1.6.6 Equality of directional patterns
 - 1.6.7 Equivalence of receiving and transmitting impedances

2 Basic Antenna Parameters and Arrays (7 hours)

- 2.1 Antenna parameters
- 2.2 Pattern multiplications
- 2.3 Two dimensional antenna arrays
 - 2.3.1 Broadside arrays
 - 2.3.2 End fire arrays
 - 2.3.3 Parasitic arrays
 - 2.3.4 Collinear arrays
- 2.4 Arrays of two point sources
 - 2.4.1 With equal amplitude and same phase
 - 2.4.2 With equal amplitude and opposite phase
 - 2.4.3 With equal amplitude and quadrature phase
 - 2.4.4 With any amplitude and any phase

3 Antenna Classifications (12 hours)

- 3.1 Electromagnetic spectrum
- 3.2 Criteria for antenna design
- 3.3 Isotropic antenna
- 3.4 Omnidirectional antennas
- 3.5 Directional antennas
- 3.6 Travelling and standing wave antennas: Long wire antenna, vee antennas, rhombic antenna
- 3.7 Wired antennas: Monopole and dipole antennas, Yagi-Uda antenna, log-periodic antenna, loop antenna, helix antenna
- 3.8 Reflector antennas: Small plane sheet and large plane sheet; Linear and corner types
- 3.9 Aperture antennas: Horn antennas types, parabolic antenna types
- 3.10 Advanced antennas: Microstrip antenna and smart antennas

4 Propagation and Radio Frequency Spectrum (7 hours)

- 4.1 Radio frequency spectrum
- 4.2 Ground wave
- 4.3 Ground reflected wave and duct propagation
- 4.4 Space wave
- 4.5 Sky wave and ionospheric layers
- 4.6 Maximum usable frequency (MUF)
- 4.7 Critical frequency and skip distance

5 Propagation between Antennas (6 hours)

- 5.1 Propagation of radio waves
- 5.2 Propagation characteristics of different band of frequencies
- 5.3 MW, SW, VHF, UHF and SHF band characteristics
- 5.4 Propagation models: Free space, two-ray and multi-path models
- 5.5 Free space propagation
- 5.6 Fresnel zones and knife edge diffraction

6 Link Budget (7 hours)

- 6.1 Introduction
- 6.2 Friis transmission equation
- 6.3 EIRP and free space loss calculation
- 6.4 Link budget calculations
 - 6.4.1 Uplink calculation
 - 6.4.2 Down-link calculation

Tutorial (15 hours)

- 1. Realization of different antenna theorems
- 2. To realize properties of EM waves: Refraction, diffraction, polarization

3. Two experiments in radiation patterns of various types of antennas
4. Calculation of mono-pole and dipole antenna of various frequencies
5. Calculation of Yagi-Uda antenna in VHF frequencies
6. Calculation of Yagi-Uda antenna in UHF frequencies
7. Antenna parameters numerical
8. Broad side and end fire antenna design concepts
9. Application and design concepts of different bands' antennas
10. Link budget calculation numerical

Practical

(22.5 hours)

1. To realize and polar plots of dipole antenna, dipole with directors and reflector
2. To realize and polar plots of long wire and vee antenna
3. To realize and polar plots of rhombic antenna
4. To realize and polar plots of Yagi-Uda antenna
5. To realize and polar plots of horn antenna
6. To realize and polar plots of reflector antenna
7. Visual presentation/observation of radio, TV stations and cable operators/ISPs

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	6	8
2	7	9
3	12	16
4	7	9
5	6	8
6	7	10
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Kraus, J. D. (1950). Antenna (Latest Edition). McGraw-Hill.
2. Balanis, C. A. (2016). Antenna theory: Analysis and design. John Wiley & Sons.
3. Collins, R. E. (1985). Antennas and radiowave propagation (Latest Edition). McGraw-Hill.
4. Gautam, A. K. (2010). Antenna and wave propagation. S. K. Kataria & Sons.