3/4 B.Tech - FIFTH SEMESTER

EC5T4 **Antennas and Wave Propagation** **Credits: 4**

Lecture : 4 periods/week **Internal assessment: 30 marks**
Tutorial: 1 period /week **Semester end examination: 70 marks**

Course Objectives:

- To expose the students to the basics of antennas and various types of antenna arrays and their radiation patterns.
- To analyze the concepts of antenna radiation and fundamental parameters.
- To understand the application of different antenna types and their characteristics.
- To study antenna array and Array factor.

Learning Outcomes:

At the completion of the course, students will be able to:

- Explain how an antenna radiates and capture radio wave energy from the concepts of radiation by dynamic currents and charges, retarded potentials(Understanding)
- Distinguish the important and fundamental engineering parameters and terminology such as radiation pattern, radiation impedance, directivity, antenna gain, effective area (Analyzing)
- Apply the Friss transmission expression and reciprocity principle effectively to predict the receive power in a system consisting of transmit and receive antenna (Applying)
- Design and analyze antenna arrays from specifications(Analyzing)
- Determine directions of maximum signal radiations and the nulls in the radiation patterns(Applying)
- Analyze VHF, UHF, Microwave Antenna Systems. (Analyzing)
- Design an antenna system, including the shape of the antenna, feed property, the requirement on the arrangement of the radiating elements in an array, given the radiation parameters such as radiation pattern, gain, operating frequency, transmit/receive power (Creating)
- Identify the mechanism of the atmospheric effects on radio wave propagation (Understanding)

UNIT- I

Antenna Fundamentals: Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna . Antenna Parameters - Radiation Patterns, Patterns in Principal Planes, Main Lobe and Side Lobes, Beam widths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency, Effective Height, Friss Transmission Equation.

UNIT- II

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. Antenna Theorems, Loop Antennas: Small Loops - Field Components, Comparison of far fields of small loop and short dipole.

UNIT-III

Antenna Arrays: 2 element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End fire Arrays, EFA with Increased Directivity, Concept of Scanning Arrays. Directivity Relations, Binomial Arrays.

UNIT-IV

Non-Resonant Radiators:Introduction, Travelling wave radiators – basic concepts, Longwire antennas – field strength calculations and patterns, V-antennas, Rhombic Antennas and Design Relations, Broadband Antennas: Helical Antennas – Significance, Geometry, basic properties; Design considerations for monofilar helical antennas in Axial Mode and Normal Modes (Qualitative Treatment).

UNIT-V

VHF, UHF and Microwave Antennas - I: Arrays with Parasitic Elements, Yagi - Uda Arrays, Folded Dipoles & their characteristics. Reflector Antennas : Flat Sheet and Corner Reflectors. Paraboloidal Reflectors – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking, Different feeding mechanisms.

UNIT-VI

VHF, UHF and Microwave Antennas - II : Horn Antennas – Types, Optimum Horns, Design Characteristics of Pyramidal Horns; Lens Antennas – Geometry, Features, Dielectric Lenses and Zoning, Applications. Antenna Measurements – Patterns Required, Set Up, Distance Criterion, Directivity and Gain Measurements.

UNIT-VII

Wave Propagation - I: Ground Wave Propagation–Characteristics, Parameters, Wave Tilt, Flat and Spherical Earth Considerations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance, Optimum Frequency, LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.

UNIT-VIII

Wave Propagation – II: Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering.

Learning Resources

Text Books:

1. Antennas for All Applications – John D. Kraus and Ronald J. Marhefka, Ahmad khan, TMH, 3rd Edition, 2008.
2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2rd Edition 2009.

References:

1. Antenna Theory - C.A. Balanis, John Wiley & Sons, 3rd Edition, 2009
2. Antennas and Wave Propagation – K.D. Prasad, SatyaPrakashan, Tech India Publications, New Delhi, 2012.
3. Electronic and Radio Engineering – F.E. Terman, McGraw-Hill, 4th edition, 1955.