

## DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16: ANTENNA THEORY AND WIRELESS NETWORK

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Antenna Theory and Wireless Network Physics DSE 16	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of digital and analog electronics and communication systems

### LEARNING OBJECTIVES

This course gives an overview of wireless communication elements and networks. Students will develop an understanding of basics of antenna, its various parameters, its usage as a transmitter and receiver. Cellular concept and system design fundamentals are described and the evolution of current wireless systems in real world such as 2G, 3G, 4G and LTE networks is discussed.

### LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- Identify basic antenna parameter (radiating wire structures).
- Determine directions of maximum signal radiations and the nulls in the radiation patterns.
- Design array antenna systems from specifications.
- Identify the characteristics of radio-wave propagation.
- Identify wireless networks 4G and LTE, and 5G.
- Design cellular systems

### SYLLABUS OF PHYSICS DSE 16

#### THEORY COMPONENT

**Unit – I** **(14 Hours)**  
ANTENNA THEORY

Introduction: Antenna as an element of wireless communication system, antenna radiation mechanism, types of antennas, fundamentals of EMFT: Maxwell's equations and their applications to antennas

Antenna Parameters: Antenna parameters: Radiation pattern (polarization patterns, field and phase patterns), field regions around antenna, radiation parameters (general idea): intensity, beam width, gain, directivity, polarization, bandwidth, efficiency and antenna temperature

**Unit – II** **(5 Hours)**

Antenna as a transmitter/receiver: Effective height and aperture, power delivered to antenna, input impedance, general idea of radiation from an infinitesimal small current element and radiation from an elementary dipole (Hertzian dipole)

**Unit – III** **(5 Hours)**

## WIRELESS NETWORKS:

Introduction: General idea of cellular and wireless systems, current wireless systems, examples of wireless communication systems, idea about global mobile communication system

### Unit – IV

(3 Hours)

Modern wireless communication systems: General idea 2G,3G and wi-fi, 4G and LTE, and 5G wireless networks, wireless local area networks (WLANs), bluetooth and personal area networks (PANs).

### Unit – V

(3 Hours)

**Cellular Concept and System Design Fundamentals:** Cellular concept and cellular system fundamentals, cellular systems design considerations (qualitative idea only)

### References:

#### Essential Readings:

- 1) Antenna Theory, Ballanis, 2<sup>nd</sup> edition, 2003, John Wiley & Sons
- 2) Electro Magnetic Waves and Radiating Systems, Jordan and Balmain, E. C., 3<sup>rd</sup> edition, 1968, Reprint (2003), PHI
- 3) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge University Press
- 4) Wireless communication and Networks, U. Dalal, 2015, Oxford University Press.
- 5) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4<sup>th</sup> edition, 1999

#### Additional Readings:

- 1) Wireless communications, A. Goldsmith, 2015, Cambridge University Press
- 2) Modern Wireless Communication, H. S. and M. M. Pearson, 3<sup>rd</sup> edition, 2005

## PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

**At least six experiments to be performed from the following list**

- 1) Study of simple dipole and folded dipole (1/2) antenna, plot and compare the radiation pattern of both antennas.
- 2) Study of simple dipole 5 element Yagi-UDA and folded dipole 5 element Yagi Uda antenna, plot and compare the radiation pattern of both antennas
- 3) Study of loop antenna and slot antennas and plot their radiation patterns
- 4) Study the radiation pattern of ground plane antenna and observe the difference in radiation pattern with single element rod, detector and reflector rods
- 5) To study the variation of radiated field with distance from transmitting antenna.
- 6) To study modulation of sine wave on RF transmitted and observe the demodulated wave on detector receiver
- 7) Study of the reciprocity theorem for antennas
- 8) Study the role of matching stub in antenna transmission.
- 9) To study working of current sensor and measurement of current in various elements of antenna.
- 10) To study and measure SWR using various types of antennas.
- 11) To study different parts of a 4G Volte mobile phone and observe constellation diagram

- for transmitter and receiver IQ signals
- 12) To study various types of faults in a 4G volte mobile phone.

**References for laboratory work:**

- 1) Antenna Theory, Ballanis, 2<sup>nd</sup> edition, 2003, John Wiley & Sons
- 2) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge University Press
- 3) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4<sup>th</sup> edition, 1999