GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2951103

Semester – V
Subject Name: Antennas and Propagation

Type of course: Compulsory

Prerequisite: Higher Engineering Mathematics, Fundamental knowledge of Engineering Electromagnetics (Maxwell's equations, three basic coordinate systems and polarization).

Rationale:
PDDC Students of EC Engineering need to possess good understanding of the fundamentals and applications of Antenna and wave propagation, including radiation from point sources as applied to antenna, antenna types and their radiation patterns. They are expected to be able to design different antennas for specific given frequency and application. They should be acquainted with concept of arrays and antenna measurement methods. They will be practiced in study of antenna radiation patterns and in measurement of different antenna parameters. They will be able to design and analyze some basic antennas in hardware and application specific antenna in HFSS or CST.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Basic antenna concepts**: Definition and functions of an antenna, comparison between an antenna & transmission line, radio communication link with transmitting antenna and a receiving antenna, radiation patterns of antennas-field and power patterns, all antenna types.	3
2	**Radiation of Electric dipole:** Potential functions and the electromagnetic field, Oscillating electric dipole-derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, Derivation for radiation resistance, application of reciprocity theorem to antennas, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	5

3	**Antenna parameters and definitions:** beam area, beam width- Half-Power Beam width (HPBW)and First Null Beam width(FNBW) ,Polarisation, Radiation Intensity ,Beam Efficiency, Directivity and directive gain, radiation resistance, radiation efficiency, resolution, Antenna aperture-physical and effective apertures, effective height, transmission formula, antenna field zones, Transmission loss as a function of frequency. Antenna temperature and signal to noise ratio.	**5**
4	**Arrays of point sources :** Expression for electric fields from two, three and N element arrays- linear arrays: Broad-side array and End-Fire array- Method of pattern multiplication- Binomial array- Horizontal and Vertical Antennas above the ground plane, Effect of ground on ungrounded antenna, Schelkunoff theorems for linear arrays, Dolph-Tchebysheff distribution for linear arrays.	**6**
5	**Loop Antenna:** Small loop short magnetic dipole, comparison of far field of small loop and short dipole loop antennas, field pattern of circular loop antenna & radiation resistance of loop antenna, directivity of circular loop antennas with uniform current.	**2**
6	**Helical antenna:** Helical geometry, transmission radiation modes, practical design considerations, wide band characteristics of helical antenna.	**2**
7	**Arrays of dipoles & apertures**: 3 element dipole Array with parasitic elements, Yagi-Uda array-function and its design, Phased arrays, frequency scanning arrays, smart antennas, long wire antennas, location methods of feeding antennas, folded dipole antennas, matching arrangements.	**4**
8	**Reflector antennas**: Parabolic reflector, paraboloidal reflector, aperture Pattern of large circular apertures with uniform illumination, off axis operation of paraboloidal reflectors, Cassegrain feed system.	4
9	**Slot patch & Horn antennas**: Slot antenna, its pattern, Babinet's principle and complementary antennas, impedance of slot antennas, and horn antenna-function and types.	3
10	**Microstrip (patch) antennas :** Rectangular and circular types-function, features analysis ,design considerations and applications	4
11	**Lens antennas**: Non-metallic Dielectric lens and artificial dielectric lens antennas, reflector lens antennas.	2
12	**Broadband & Freq. Independent antennas**: Broadband antenna, Frequency independent antenna, log periodic antennas.	2
13	**Antennas for special applications:** Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma antenna.	2
14	**Antennas measurements**: Experimental set ups for measurement of radiation patterns, gain, phase polarization, terminal impedance.	2
15	**Radio wave propagation** : Modes of propagation, Ground Wave Propagation, Structure of troposphere and	6

	ionosphere, Characteristic of Ionospheric layers, Sky wave propagation, Definitions for Virtual height, MUF and Skip distance, OWF, Fading, ionospheric absorptions, Multi-hop propagation, Space wave propagation and Super refraction.	

Reference Books:

1. "Antennas for all applications", J.D. Krauss 3RD Edition (TMH)
2. "Electromagnetic wave & radiating systems", Jordan & Balmain PHI Publication
3. "Antenna & Wave Propagation", K.D. Prasad Satyaprakash Publications
4. "Antenna Theory: Analysis and design", C. Balanis Wiley India

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the radiation phenomenon and identify different types of antennas	20
CO-2	Create strong foundation of basic antenna parameters.	25
CO-3	Design and analyze different antennas, antenna arrays **a**nd matching / feeding networks for antennas	25
CO-4	Demonstrate the antenna measurement techniques.	10
CO-5	Understand the fundamentals of radio-wave propagation	20

List of Experiments:

Sr.No.	Experiment Title
1.	To study the variation of radiated field with distance from transmitting antenna.
2.	To demonstrate the reciprocity theorem for transmitting and receiving radiation patterns of an antenna.
3.	To plot the radiation pattern of an Omni directional antenna.
4.	To plot radiation pattern of directional antenna.
5.	To study Phenomena of Circular, Linear and Elliptical Polarization of antennas.
6.	To study and plot the radiation pattern of the dipole/Folded dipole antennas in Azimuth & Elevation planes.

7.	To study and plot the radiation pattern of the helical antenna.
8.	To study and plot the radiation pattern of the parabolic reflector.
9.	To study and plot the radiation pattern of the Log-Periodic antenna.
10.	To study and plot the radiation pattern of the Broadside antennas and Measure its Gain, Bandwidth and Beam width.
11.	To plot radiation pattern of 3λ/2 dipole antenna and compare with λ/2 dipole antenna.
12.	To plot the radiation pattern of a Slot antenna.
13.	Design and simulate micro strip patch antenna in HFSS simulator.

Major Equipment:

1. RF Synthesizer
2. RF Detector or spectrum analyzer
3. Antenna kit