GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3720512
Semester – II
Subject Name: Antennas and Radiating Systems

Type of course: Elective I

Prerequisite: This course assumes that students have had an introduction to Higher Engineering Mathematics, Fundamental knowledge of Engineering Electromagnetics (Maxwell's equations, three basic coordinate systems and polarization).

Rationale: This course provides a comprehensive understandinging 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 software tolls like HFSS,CST etc.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	PA(V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Review of Antenna Theory:** Fundamental theory of antennas: Reciprocity theorem, Antenna equivalent Circuit, Classification of antennas, Special types of Antennas for different frequency bands.	6	12
2	**Antenna Parameters:** Radiation Impedance, Radiation Pattern, Antenna Impedance, Bandwidth, Directivity, Gain, Antenna efficiency, Radiation Efficiency, Antenna Polarization, Antenna Vector effective length, Antenna Apertures, Antenna temperature, near-field and far-field concepts, and radiation and far-field concepts, and radiation mechanism. Input Impedance, Friis Transmission equation.	7	18
3	**Arrays: Linear, Planar, and Circular:** Two-Element Array N-Element Linear Array: Uniform Amplitude and Spacing N Element Linear Array: Directivity Design Procedure ,N Element Linear	8	12

	Array :Three-Dimensional Characteristics Rectangular-to-Polar Graphical Solution , Broadside and End fire array, N-Element Linear Array: Uniform Spacing, Nonuniform, Super directivity, Binomial Array Amplitude , Planar and Circular Arrays.		
4	**Antenna synthesis:** Introduction to various methods of antenna synthesis such as Schelkunoff Polynomial, Fourier transform, Woodward Lawson.Dolph-Chebyshev,Triangular, Cosine, and Cosine-Squared Amplitude Distributions	5	10
5	**Micro strip Antennas :** Rectangular and Circular Patch, Quality Factor, Bandwidth, and Efficiency, Input Impedance, Coupling, Circular Polarization, Arrays and Feed Networks, Multi Band, Recent advances in fractal antenna and patch array. Applications in Wireless and Satellite communication, electromagnetic effects in high speed digital circuits, bio electromagnetics, Electromagnetic hazards and the environment.	6	12
6	**Horn and Reflector antenna:** Horn Antennas - Rectangular Horn (Pyramidal), Circular Aperture Horn, Circular (Conical) Corrugated Horn Reflector Antennas - Paraboloidal Reflector Geometry, Dual Reflector Antennas and feeds, Spherical Reflector, Shaped Reflectors,	4	10
7	**Phased arrays:** Fixed Phase Shifters or Phasers, Non-uniform and Random Element Existence Arrays, Feed Networks, Adaptive Antenna & Digital beam forming, smart antenna for wireless communication	4	10
8	**Antenna Analysis:** Introduction to antenna analysis methods: Integral equation method, Moment method, Finite Difference Time Domain methods; Applications of these methods to the practical antennas such as dipole, loop, helical, microstrip patch, and PIFA.	6	10
9	**Antenna Optimization Techniques:** Various optimization techniques (OT) such as Genetic algorithm, Artificial Intelligence, Fuzzy logic. Comparative analysis of the OT's for particular application and antenna type.	2	6
	Total	**48**	100

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**20**	**30**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Balanis C A, Antenna Theory:Analysis and design, Wiley
2. J.D.Krass, Antennas McGraw Hill.
3. Hohnson R C and H Jasik, Antenna Engineering Handbooks, McGraw Hill
4. Ramo, Whinnery, Fields and waves in communication electronics John Wiley
5. Robert Stratman Elliott, 'Antenna Theory and Design', Prentice-Hall, 1981 David Olver, 'Microwave Horns and Feeds', IEEE Press
6. Allan Walter Love, 'Reflector antennas', IEEE Antennas and Propagation Society
7. A.W. Love, 'Electromagnetic Horn Antennas', IEEE press
8. Robert J. Mailloux, 'Phased Array Antenna Handbook' ARTECH HOUSE
9. J.D. Kraus and Daniel A Fleisch ,Electromagnetics with Applications,TMH,5Th edition

Course Outcomes:

A student who successfully completes this course should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	To apply basic principles of problem solving in antenna and radiating systems for the society and environment	**20**
CO-2	To analyze and design antenna and radiating systems like dipole antennas and its variants, antenna arrays,microstrip antennas, horn antennas,reflector antennas for the society and environment in ethical way	30
CO-3	To prepare post graduates with the knowledge, ethics and skills so that they can be applied to various applications of antennas in environment friendly manner for the society	20
CO-4	To build projects individually or in a group consisting of antenna and radiating systems system as per the need of the society in a professional ethical and environment friendly manner	20
CO-5	To apply the knowledge of antenna and radiating systems to troubleshoot the antenna and radiating systems products in ethical way and constructively useful for the society and environment	10

Suggested Experiment List

1. To study the variation of field strength of radiated with distance from transmitting antenna.

2. To demonstrate that the transmitting and receiving radiation patterns of an antenna are equal and hence confirm the reciprocity theorem of antennas.
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 on log & linear scales on polar and Cartesian plots.
7. To study and plot the radiation pattern of the helical antennas and Measure its Bandwidth and Beam width.
8. To study and plot the radiation pattern of the parabolic reflector and Measure its Gain, Bandwidth and Beam width.
9. To study and plot the radiation pattern of the Broadside antennas and Measure its Gain, Bandwidth and Beam width.
10. Design and simulate micro strip patch antenna in HFSS simulator.
11. To plot the radiation pattern of a Slot antenna.
12. To plot radiation pattern of $3\lambda/2$ dipole antenna.

List of Open Source Software/learning website:

- Scilab
- http://www.vlab.co.in/ (Virtual labs at IIT Guwahati)
- NTPEL
- HFSS
- CST