GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electronics and Communication
Subject Code: BE05000381
Subject Name: Antennas and Wave Propagation

WEF Academic Year:	2025-26
Semester:	5
Category of the Course:	Professional Elective Course - 1

Course Outcome :

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Understand the radiation phenomenon and identify different types of antennas	UN
02	Create strong foundation of basic antenna parameters.	AN
03	Design and analyze different antennas, antenna arrays **a**nd matching / feeding networks for antennas	AN
04	Demonstrate the antenna measurement techniques.	CR
05	Understand the fundamentals of radio-wave propagation	UN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course 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	3

	patterns of antennas-field and power patterns, all antenna types.	
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.	**6**
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.	**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, Effect of ground on ungrounded antenna, Dolph-Tchebysheff distribution for linear arrays.	**5**
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.	**3**
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, location methods of feeding antennas, folded dipole antennas, matching arrangements.	**3**
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.	**3**
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	**3**
11	Broadband & Freq. Independent antennas: Broadband antenna, Frequency independent antenna, log periodic antennas.	**3**
12	Antennas measurements: Experimental set ups for measurement of radiation patterns, gain, phase polarization, terminal impedance.	**2**

13	Radio wave propagation : Modes of propagation, Ground Wave Propagation, Structure of troposphere and 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.	**4**

This syllabus is mapped with following United Nation's Sustainable Development Goals:

SDG 3 - Good Health and Well-being
SDG 4 - Quality Education.
SDG 9 - Industry, Innovation and Infrastructure,
SDG 11 - Sustainable Cities and Communities,
SDG 13 -Climate Action
SDG 17 - Partnerships for the Goals

Relevant BIS standards:

IS/IEC 61000 Series – Electromagnetic Compatibility (EMC)
IS 14700 Series – EMC Requirements for Electronic Equipment
IS 13252 (Part 1) – Safety of Information Technology Equipment
IS 302-1 – Safety of Household and Similar Electrical Appliances
Guidelines by Telecom Regulatory Authority of India (TRAI) on:

- Electromagnetic Field (EMF) exposure limits
- Mobile tower radiation safety norms

Department of Telecommunications (DoT) guidelines on:

- Base station radiation compliance
- SAR (Specific Absorption Rate) limits

Also explore other relevant Indian and international standards.

Reference Book :

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

Suggested Course Practical List :

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/software:

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

List of Laboratory/Learning Resources Required:

- NPTEL

Activities suggested under Self-learning/Team Work:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain

			observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions

12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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