

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**Course Curriculum**

**ANTENNA AND WAVE PROPAGATION**

**(Code: 3331101)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Electronics & Communication Engineering	3 <sup>rd</sup> semester

**1. RATIONALE**

Antennas play vital role in wireless communication as a terminal component of transmitter and receiver systems. The quality of signals at receiver depends on type of transmitting and receiving antennas, their orientation, transmitting frequency and geographical terrain. For installation & maintenance of wireless systems the basic knowledge of wave propagation theory is essential. This course will help the students to select and install antennas of desired operating frequency for the particular application. It is therefore a core engineering course for electronic and communication engineers and hence students should learn this course for efficient working in field.

**2. COMPETENCY (Programme Outcome according to NBA Terminology):**

The course content should be taught and with the aim to develop different types of skills so that students are able to acquire following competency

- **Select (with specifications) appropriate antenna for specific wireless communication system.**

**3. TEACHING AND EXAMINATION SCHEME**

<b>Teaching Scheme (In Hours)</b>			<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>				
<b>L</b>	<b>T</b>	<b>P</b>		<b>Theory Marks</b>		<b>Practical Marks</b>		<b>Total Marks</b>
			<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	
03	00	02	05	70	30	20	30	<b>150</b>

**Legends:** L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

#### 4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
<b>Unit – I Basic Electromagnetic Theory</b>	1a. Describe properties of electromagnetic waves. 1b. Explain the basic concepts of electromagnetic wave theory.	1.1. Physical concept of generation of EM Wave. • Static electric & magnetic field of steady electric current. • Electromagnetic field and its radiation from a center fed dipole.
	1c. Describe the basic radiating antennas. 1d. For the given application choose the relevant radiator	1.2 Elementary radiator • Hertzian dipole; Half-wave dipole, Power radiated by elementary dipole using Poynting Vector method.
<b>Unit – II Antenna Terminologies</b>	2a. Distinguish between antenna and aerial. 2b. Calculate the basic antenna parameters using standard formulas. 2c. Identify antenna specifications required from standard handbooks.	2.1. Basic parameters: Aerial and antenna, Antenna Impedance, Radiation Resistance, Radiation Pattern, Beam area and beam efficiency, Isotropic radiator gain, directivity and Gain, radiation intensity, half power BW, polarization, antenna losses, antenna efficiency, effective aperture, effective length of antenna, effects of antenna height, antenna temperature, front to back ratio, antenna field zones
<b>Unit – III Basic Antennas &amp; Arrays.</b>	3a. Select antennas and antenna arrays as per their operating frequency ranges and radiation pattern for the specific applications	3.1 Radiation characteristics of wire antennas: Resonant wire antennas ( $\lambda$ , $2\lambda$ ), Non Resonant (Rhombic) Antenna 3.2 Loop antenna 3.3 Folded dipole 3.4 Antenna Arrays: Uniform linear array, Broad side array, End fire array 3.5 Yagi-uda antenna
<b>Unit – IV Antennas for Special applications</b>	4a. Classify antennas used in VHF/ UHF band	4.1 VHF/UHF antennas: Helical antenna, Parabolic reflector antenna, Horn antenna, Micro strip (patch) antenna, Turnstile and super turnstile antenna, slot antenna
	4b. Identify mobile network antennas.	4.2 Terrestrial mobile communication antennas: Base station antennas, Mobile station antennas
	4a. Explain the concept of Smart Antennas and its applications	4.3 Smart Antennas : Need & Applications
	4a. Prepare the specifications for the required indoor or outdoor DTH systems	4.4 DTH receiver system: outdoor unit, antenna system and indoor unit
<b>Unit – V Wave</b>	5a Explain the effect of ground on electromagnetic waves	5.1 Ground Wave propagation 5.2 Ionosphere Layers and Sky wave

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Propagation	propagation. 5b Explain properties of Ionospheric layer used for electromagnetic wave propagation.	propagation: Virtual Height, Critical frequency, Maximum usable frequency (MUF), Skip distance, Lowest Usable frequency (LUF), Optimum Usable frequency ( OUF)
	5c Explain different modes of wave propagations 5d Select the antennas for specific mode of wave propagation considering all the aspects discussed thus far	5.3 Space Wave propagation: Tropospheric scattered propagation, Duct Propagation

### 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic Electromagnetic Theory	05	4	4	2	10
II	Antenna Terminologies	07	4	4	4	12
III	Basic Antennas & Arrays.	12	5	5	8	18
IV	Antennas for Special applications	10	5	5	6	16
V	Wave Propagation	8	3	3	8	14
<b>Total</b>		<b>42</b>	<b>21</b>	<b>21</b>	<b>28</b>	<b>70</b>

**Legends:** R = Remember; U = Understand; A = Apply and above levels (Bloom's revised 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.

### 6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course Outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

**Note:** Here only Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise(Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx. Hrs. Required
1.	I	Check the radiation pattern of half wave dipole and find HPBW.	02
2.	III	Check the radiation pattern of rhombic antenna.	02
3.	III	Check radiation pattern of loop antenna.	02
4.	III	Check radiation pattern of folded dipole antenna.	02
5.	III	Fabricate the demonstrative physical model of Yagi –Uda antenna with at least 3 radiator and one reflector.	02
6.	III	Test the performance of the Yagi –uda antenna.	02
7.	III	Test the performance of the broad side array.	02
8.	III	Test the performance of the end fire array antenna.	02
9.	IV	Test the performance of helical antenna in horizontal and vertical planes	02
10.	IV	Check the radiation pattern of parabolic reflector antenna.	02
11.	IV	Test the performance of horn antenna.	02
12.	IV	Select the relevant Mobile Antenna System for a particular area	02
13.	IV	Install and commission DTH receiver systems	04
		<b>Total</b>	<b>28</b>

## 7. SUGGESTED LIST OF STUDENTS ACTIVITIES

Following is the list of proposed students activities like:

- i. Prepare the chart of various antenna radiation patterns.
- ii. Collect details of different types of antenna parameters used in radio/TV transmitter, cellular system, wireless radio set, Radar.
- iii. Prepare the demonstration model of commonly used antennas.
- iv. Prepare the PPT/animations of 3-D radiation pattern and wave propagation of radio waves.
- v. Undertake literature survey and internet search and also handbook/datasheet search for specifications of given antenna.
- vi. Install and commission DTH systems.
- vii. Visit Satellite Earth Station (SAC)/ Doordarshan / AIR/ FM Radio Station.

## 8. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

- i. In Unit I & II, the fundamental wave propagation equations and formulas of electromagnetic wave propagation theory can be explained without mathematical derivations.
- ii. For Unit III, IV & V the teacher should arrange visits to different communication research laboratories as well as state of art industries to justify and reinforce the theory taught.
- iii. To familiarizing the working of various type of antennas demonstrate the use of radiation measuring meter , radiation generation instrument and various types of antennas as listed in unit III to the students in the lab period.
- iv. Introduce the latest simulation software for better understanding of radiation pattern of various types of antennas.
- v. To support and enhance the understanding of the fundamental theory of wave propagation in unit I & V, use of animations and simulation software are recommended.

## 9. SUGGESTED LEARNING RESOURCES

### A) List of Books

S. No.	Title of Books	Author	Publication
1	Antennas and Wave Propagation	Kraus John D, Marhefka Ronald J. and Khan Ahmad S.	Tata McGraw-Hill Education, Fourth Edition, or latest
2	Antennas and Wave Propagation	Raju, G. S. N.	Pearson Education India, 3 <sup>rd</sup> edition or latest
3	Antenna and Wave propagations	Prasad, K.D. and Handa, Deepak	Satya Prakashan , New Delhi, 3 <sup>rd</sup> edition or latest
4	Antenna and Wave propagations	Das, Sisir and Das K. Annapurna	Tata McGraw-Hill Education, 2013
5	Antenna and Wave propagations	Harish, A. R. And Sachidananda M.	Oxford University Press, 4 <sup>th</sup> Edition or latest
6	Electronic Communication Systems,	Kennedy, George and Davis, Bernard	Tata McGraw-Hill Education, 4 <sup>th</sup> Edition or latest

### B) List of Major Equipments /Materials

- i. Experimental antenna trainer kit (preferred with software simulator)
- ii. Spectrum analyser - 30 MHz.
- iii. Standard DTH receiver system.
- iv. Antenna synthesis simulation demonstrative software.

### C) List of Software/Learning Websites

- i. [www.cst.com](http://www.cst.com)
- ii. <http://www.antennamagus.com/>
- iii. <http://www.antennamagus.com/antennas.php?page=antennas>
- iv. <http://emcos.com/Antenna-Simulation-and-Optimization>
- v. [http://www.apparentlyapparel.com/uploads/5/3/5/6/5356442/practical\\_antenna\\_handbook\\_fourth\\_edition\\_carr.pdf](http://www.apparentlyapparel.com/uploads/5/3/5/6/5356442/practical_antenna_handbook_fourth_edition_carr.pdf)

## 10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- **Prof. U.V. Buch**, Lecturer(SG), Government Polytechnic, Gandhinagar.
- **Prof. J.D. Chauhan**, Lecturer, B & B Institute of Technology, V.V.Nagar.
- **Prof. M.R. Mandli**, Lecturer, Government Polytechnic, Rajkot.
- **Prof. Deepak P. Parikh**, Lecturer, Sigma Institute of Technology (Polytechnic), Vadodara.

### Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Anjali Potnis**, Assistant Professor, Department of Electrical and Electronics Engineering.
- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.