Techno India NJR Institute of Technology

Course File

Session 2021-22

Antennas and Propagation (6EC4-04)

For Techno India NJR Institute of Technology
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SYLLABUS

III Year - VI Semester: B.Tech. (Electronics & Communication Engineering)

6EC4-04: Antennas and Propagation

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Fundamental Concepts-Physical concept of radiation, Radiation pattern, near andfar-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.	7
3	Radiation from Wires and Loops-Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.	6
4	Aperture and Reflector Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.	7
5	Broadband Antennas-Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.	5
6	Micro strip Antennas-Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.	6
7	Antenna Arrays-Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schellkun off polynomial method, Woodward-Lawson method.	5
8	Basic Concepts of Smart Antennas-Concept and benefits of smart antennas, fixed weight beamforming basics, Adaptive beam forming.	4
9	Different modes of Radio Wave propagation used in current practice.	1
	Total	42

Course Overview:

Student will learn fundamentals of Antenna wave and propagation from this 40-hour course. In this course, student will study the fundamental concepts and application of antennas and its radiation parameter. Also, they will studydesigning, different measurement and calculations related to various antenna. Other than this, they will also learn about radio wave propagation and smart antennas used in recent technologies.

Course Outcomes:

CO.NO.	Cognitive Level	Course Outcome
1	Knowledge	Define various antenna parameters
2	Analysis	Illustrate techniques for antenna parameter measurements.
3	Synthesis	Synthesize the various applications of antennas

Prerequisites:

1. Fundamentals of various orthogonal coordinate systems.
2. Must have completed the course on electromagnetic waves.
3. Student should be able to solve the problems of electromagnetic fields.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific					Domain Independent						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	2	1							
CO2	2	2	1	2	1							
CO3	2	1	1	0	0							
1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)												

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION: Objective, scope and outcome of the course**
2	**2**	**FUNDAMENTAL CONCEPTS OF ANTENNA:** Physical concept of radiation
3	2	Radiation pattern, near and far-field regions
4	2	Reciprocity
5	2	Directivity and gain
6	2	Effective aperture, polarization

7	2	Input impedance, efficiency
8	2	Friis transmission equation
9	2	Radiation integrals and auxiliary potential functions
10	**3**	**RADIATION FROM WIRES AND LOOPS**
11	3	Infinitesimal dipole
12	3	Half-wave and monopole dipole
13	3	Small circular loop
14	3	linear elements near conductors
15	3	Dipoles for mobile communication
16	**4**	**APERTURE AND REFLECTOR ANTENNAS:** Huygens' principle
17	4	Radiation and design considerations of rectangular apertures
18	4	Radiation and design considerations of circular apertures
19	4	Babinet's principle
20	4	Radiation from sectoral and pyramidal horns
21	4	design concepts of prime-focus parabolic reflector antenna
22	4	design concepts of cassegrain antennas
23	**5**	**BROADBAND ANTENNAS:**
24	5	Log-periodic antenna
25	5	Yagi-Uda antenna
26	5	Frequency independent antennas
27	5	Broadcast antennas
28	**6**	**MICRO STRIP ANTENNAS**
29	6	Basic characteristics of micro strip antennas, feeding methods
30	6	Different methods of analysis
31	6	Design of rectangular patch antennas
32	6	Design of circular patch antennas
33	**7**	**ANTENNA ARRAYS-** Analysis of uniformly spaced arrays with uniform amplitude excitation
34	7	Analysis of uniformly spaced arrays with non-uniform amplitude excitation
35	7	Extension to planar arrays
36	7	Synthesis of antenna arrays using Schelkun off polynomial method
37	7	Synthesis using Woodward-Lawson method
38	**8**	**BASIC CONCEPTS OF SMART ANTENNAS**
39	8	Benefits of smart antennas, Fixed weight and adaptive beamforming
40	**9**	**DIFFERENT MODES OF RADIO WAVE PROPAGATION USED IN CURRENT PRACTICE**

TEXT/REFERENCE BOOKS

1. Antenna theory, Analysis and design, 3rd edition, Balanis Constantine A, John Wiley & Sons Inc. Publication
2. Antenna and wave propagation, K.D. Prasad, Satya Prakashan, New Delhi.
3. Antenna and wave propagation, Sisir. Das and A. Das, Tata McGraw-Hill Education Pvt. Ltd

Teaching and Learning resources:

- **MOOC (NPTEL): -** https://nptel.ac.in/courses/108/101/108101092/

Assessment Methodology:

1. Practical exam using lab instruments.
2. Two Midterm exams where student have to showcase subjective learning.
3. Final Exam (subjective paper) at the end of the semester.

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B.Tech. VII- Semester (Main&Back) Examination, Nov. - 2019
Electronics And Comm. Engg.
7EC1A Antenna And Wave Propagation

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 26

Instructions to Candidates:

Attempt any five questions, selecting one question from each unit. All Questions carry equal marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly). Units of quantities used/calculated must be stated clearly.

UNIT - I

1. a) Describe ideal dipole and short dipole antenna. **(6)**

   b) Describe the difference between directivity and gain. Are they the same in any case? **(4)**

   c) Prove that the radiated power of quarter wave monopole is $P_r = 36.5\, I_{in}^2$. **(6)**

(OR)

1. a) Draw the equivalent circuit of antenna. Also define the polarisation, antenna front to back ratio (FBR), Antenna band width. **(8)**

   b) Determine the maximum effective aperture and directivity of a short dipole supposed to be operated at f = 450 MHz. **(8)**

UNIT - II

2. a) What are the advantages of array antenna? Describing principle of pattern multiplication and sketch the radiation pattern of a three - element array separated at $\lambda/2$. **(8)**

   b) Calculate the directivity a broad side stacked antenna of height 10.5 m and length 21 m in dB, if operating frequency f = 3.5 GHz. **(8)**

(OR)

2. a) Distinguish between endfire and broadside arrays. Show that array of two isotropic sources fed with equal amplitudes and opposite phases acts as an end - fire array. **(8)**

   b) Describe and draw the radiation pattern of 4-isotropic sources of equal amplitudes and phases in broadside and end-fire arrays. **(8)**

UNIT - III

3. a) Compare half - wave dipole, folded dipole antenna and V - dipole antennas in terms of designs and radiation characteristics. (8)

b) What are the characteristics features of circular end square loop antennas? Write the expressions for their far fields. (8)

(OR)

3. a) Describe the principle of operation of Yagi - Uda antenna. Explain its properties with reference to directivity and bandwidth. (8)

b) Describe the design procedure of rectangular patch antenna with a suitable example. Write its applications. (8)

UNIT - IV

4. a) Describe the effect of frequency, earth constant and earth curvature on surface wave propagation. (8)

b) Describe the troposphere and troposphere wave propagation. Also justify the statement "Microwave communication is only due to tropospheric propagation". (8)

(OR)

4. a) Define the terms surface and elevated ducts and duct gradient. Also describe duct propagation. (8)

b) Show that for space wave propagation the filed intensity at the receiver is given by $E_R = \frac{88\sqrt{P}h_t hr}{\lambda a^2}$ v/m. (8)

UNIT - V

a) Describe the ionosphere reflection of radio waves. Derive an expression for critical frequency of a reflecting layer in terms of its ionization density. (8)

b) Describe D,E,F, and G layers of the ionosphere. (4)

c) Estimate the maximum electron density of an ionosphere layer for a critical frequency 5.5 GHz. (4)

(OR)

a) Write notes on virtual height, skip distance, maximum usable frequency, and optimum working frequency. (8)

b) For a mobile communication over a height of 120 km via ionosphere layer with Nmax = 2.22×10^5 electrons/m^3, the maximum frequency estimated to be is 6.5 KHz. Find the optimum working frequency, critical frequency, and elevation angle of beam and path range. (8)