**Course Curriculum of Antenna Engineering**

Course Code : ECE-3207 Course Title : Antenna Engineering

Semester : 6th Level : Undergraduate

Credit : 3 Contact Hours/Wk : 3

Section : 2 **Pre-Requisites :** ECE 2205

Performance and Attendance: 10% Class Test: 20% Final Examination: 70%

**Objectives :**

The purpose of this course is to give Electronics and Communication Engineering students a basic understanding of antenna theory, and knowledge of the characteristics and design of various antenna types. The courses are designed for engineers, scientists, engineering managers, antenna technicians, antennas measurement technicians and project planners. It can help you, or your employees, understand fundamental properties, operations, uses and applications of antennas.

The course is to educate students' professional knowledge, and the ability to innovate, analyze, design and practice, in order to develop the professional knowledge in Electronics and communication engineering, academic research, and interdisciplinary integration.

It is to educate students’ with broad knowledge, communication skills and teamwork, in order to meet the challenges of different career developments, and to recognize the necessity of lifelong learning.

**Contents :**

**Section : A**

**Fundamental of Antennas:** Radiation Mechanism, Radiation Patterns, Lobes, Power Density and Intensity, Directive Gain and Directivity, Power Gain, Bandwidths, Radiation Efficiency, Input Impedance, Effective Aperture and Antenna Temperature. Vector Potential Functions, Electric and Magnetic Fields for Electric and Magnetic Current Sources, Solution of Vector Potential Wave Equation, Duality, Reciprocity and Reaction Theorems.

**Linear Wire and Loop Antennas**: Infinitesimal, Small, Finite Length and Half-wave Length Dipoles, Determination of Radiation Fields, Radiation Patterns, Radiation Resistance, Directivity and Input Impedance of Dipoles, Mutual Impedance Between Linear Elements Near Infinite Planes Conductors and Ground Effects.   Circular, Square, Triangular, Rectangular, Rhombic and Ferrite Loop Antennas. Cylindrical Dipole, Folded Dipole.

**Section : B**

**Antenna Arrays:** Antenna array, Controls in antenna array, Linear and uniform linear array, Broadside, End Fire, Collinear, and Parasitic arrays, Array of two point sources with amplitude and phase analysis, Pattern multiplication, Radiation pattern of 4- & 8- isotropic elements fed in phase and spaced λ/2 apart, Array of n-isotropic sources of equal amplitude and spacing, Broadside Case (direction of pattern maxima, direction of pattern minima, beam width of major lobe), Tapering of arrays, Binomial arrays, Dolph-Tchebyscheff arrays, Super-directive arrays, Array factor of planer array, Array factor of circular array.

**Travelling Wave and Broadband Antennas:** Long wire antenna, V antenna, Direction conversion of V antenna, Rhombic antenna. Helical antenna, Yagi-Uda antenna. Frequency Independent Antennas and Antenna Miniaturization: Condition for frequency independence, Frequency independent log periodic antennas, Design of dipole array log periodic antenna, Fundamental limits of electrically small antennas**.**

**Aperture Antennas:** Huygens principle, Rectangular aperture, Circular aperture, Design consideration for rectangular and circular aperture, Babinet’s principle.

**Microstrip Antennas:** Basic characteristics, Feeding method, Transmission line model of rectangular patch (Fringing effects, Effective length, Resonant frequency, Effective width, Design method, Conductance, Resonant input resistance).

**Horn, Reflector and Lens Antennas:** Sectoral horn and its directivity measurement, Pyramidal horn and its design procedure, Conical horn, Parabolic reflector, Cassegrain reflector, Lens Antenna, Nonmetallic dielectric lens antenna, E-plane metal plate lens antenna.

**Broadband Dipoles and Matching Techniques:** Cylindrical dipole antenna, Folded dipole antenna, Sleeve dipole antenna, Matching techniques, Balun transformers.

**Section B Details**

**Antenna Array [Lectures 1st to 5th]**

* 1. Antenna array, Linear array, Uniform Linear array, Phase - 7.1
  2. Various forms antenna array (Broadside array, End fire array, Collinear array, Radiation pattern of Bidirectional can be convert into unidirectional for broadside array, Comparison of arrays, Collinear array is sometimes called broadside array or omnidirectional array)-7.2
  3. Parasitic arrays-7.2.4
  4. Arrays of point sources (Arrays of two point sources, in phase and opposite phases)-7.3, 7.3.1, 7.3.2
  5. Pattern Multiplication (4 and 8 Isotropic elements feed in phase) – 7.5, 7.5.1, 7.5.2
  6. Linear with n isotropic point sources (Direction of pattern maxima, Direction of pattern minima)- 7.6, 7.7, 7.7.1,7.7.2,7.7.3,, 7.8,7.8.1,7.8.27.8.3
  7. Tapering of array(Side lobe level, Side lobe ratio, Tapering)-7.12
  8. Binomial array (Tapering Technique)-7.13
  9. Dolph-Tchebyscefe arrays (Tapering Technique) -7.14
  10. Supergain or Superdirective array-7.17

Practical Antennas (VLF, LF, MF, HF) **[Lecture 6th]**

2.1 Introduction and VLF & LF antennas-8.0, 8.1

2.2 **Travelling wave antenna** (Physical Structure, Operating principle, Radiation pattern, uses)-8.15

**[Lecture 7th]**

3.1 **The V-antenna** (Physical Structure, Operating principle, Radiation pattern, uses)-8.12

3.2 Bidirectional radiation pattern can be converted into unidirectional for V-antenna-8.12

3.3 Techniques for increasing the directivity and gain for V-antenna.-8.12

4.1 **The Inverted V-antenna** (Physical Structure, Operating principle, Radiation pattern, uses)-8.13

4.2 Image antenna -8.13, 8.3.1

4.3 Inverted V antenna acts as a Rhombic antenna, Monopole antenna acts as a Dipole antenna- Justify

the Statement

**[Lectures 8th and 9th]**

5.1 **Rhombic antenna** (Physical Structure, Operating principle, Radiation pattern, uses)-8.14

5.2 Unidirectional radiation pattern converted into bidirectional for Rhombic antenna-8.14

5.3 Designing techniques of Rhombic antenna-8.14.1

5.4 Value of length (L) and height (h) of the leg for designing the Rhombic antenna-8.14.2

5.5 Advantages and Disadvantages of Rhombic antenna,-8.14.4, 8.14.5

5.6 Overcome the disadvantages-8.14.6

5.7 Techniques for increasing the directivity and gain for Rhombic antenna-8.14.6

5.8 Different types of connection of Rhombic antenna, MUSA Connection-8.14.6

**[Lecture 10th]**

6.1 **Ferrite Rod Antenna** (Physical Structure, Operating principle, Radiation pattern, uses)-8.24

6.2 Figure of the antenna and it’s equivalent circuit-8.24

6.3 Find the value of maximum emf (V) and effective length (le) of the antenna-8.24

Practical Antennas (VHF, UHF, SHF)

**[Lecture 11th]**

7.1 Introduction and classifications of different antennas -9.1

7.2 **Folded Dipole antenna**-(Physical Structure, Operating principle, Radiation pattern, uses)-9.2

7.3 Input impedance at the terminals of a folded dipole antenna is equal to the square of number of conductors-9.2

7.4 Equation of input impedance, Z=n2x73 -9.2.1

7.5 Find the value of Z for different parameters-9.2.1

7.6 Advantages and Uses of the antenna-9.2.3

**[Lecture 12th]**

8.1 **Yagi-Uda antenna**-(Physical Structure, Operating principle, Radiation pattern, uses)-9.3

8.2 Length of 3 elements array the antenna-9.3

8.3 Describe antenna action-9.3.1.

8.4 General characteristics of the antenna-9.3.2

8.5 Beam antenna -9.3.2

8.6 Establish the voltage and current relation of the parasitic antenna/Value the voltage (V), Current (I) and Impedance (Z) of the antenna, (Z=Z1 1x Zratio) -9.3.3

**[Lecture 13th]**

9.1 **Helical antenna**-(Physical Structure, Operating principle, Radiation pattern, uses)-9.6, 9.6.3

9.2 Modes of Radiation (Normal mode, Axial Mode)-9.6.1, 9.6.2

9.3 Condition for pitch angle to get circular polarization-9.6.1

9.4 Helical antenna sometimes acts as a loop/small dipole antenna----Justify/Conditions-9.6.1

9.5 Polarization of this antenna-Vertical/Horizontal/Circular---Expalin-9.6.1

9.6 Value of Pitch angle (α) for Normal mode of operation -9.6.1

9.7 Axial mode of Radiation -9.6.2

10.1 Babinet’s Principle and Complementary antenna-9.8

**[Lecture 14th]**

11.1 **Microstrip or patch antenna**-(Physical Structure, Operating principle, Radiation pattern, uses)-9.11

11.2 Value of Characteristic Impedance (Zc) -9.11

11.3 Limitations of Microstrip antenna and technique for overcoming the limitations-9.11.1

11.4 Techniques for increasing the bandwidth and directivity of patch antenna-9.11.1

**[Lecture 15th]**

12.1 **Frequency Independent Log-Periodic antenna** -(Physical Structure, Operating principle, Radiation pattern, uses)-9.16, 9.16.4

12.2 Why it is called Log Periodic?-9.16

12.3 Description of regions of Log periodic antenna (with figure)-9.16

12.4 General characteristics of Log periodic antenna-9.16.1

12.5 Value of apex angle (α) -9.16.2

12.6 Relation between apex angle and spacing factor-9.16.2

12.7 Practical log periodic Structure-9.16.3

Microwave Antennas **[Lectures 16th and 17th]**

13.1 **Parabolic Reflectors** -(Physical Structure, Operating principle, Radiation pattern, uses)-9.18

13.2 Value of BWFN, HPBW, Gp-9.18.2

13.3 Aperture number (f/D) may be in different place for different meanings- Explain the meanings-9.18.2

13.4 Effective radiated power (ERP), Spillover, Backlobe – 9.18.2

13.5 Find the value of aperture number (f/D) and value of focal length f – 9.18.2

13.6 Different types parabolic reflectors (truncated paraboloid, Cylinderical paraboloid, Pill box or Cheese antenna– 9.18.3

13.7 Primary and Secondary pattern and radiator-9.18.4

13.8 Feeding System, Ideal feed -9.18.5

13.9 Cassegrain feeding and it’s advantages and disadvantages, Overcome disadvantages-9.18.6

13.10 Line source feed for parabolic cylinder and pill box antennas-9.18.9

**[Lecture 18th]**

14.1 **Lens Antennas** -(Physical Structure, Operating principle, Radiation pattern, uses)-9.19, 9.19.1, 9.19.5

14.2 Types of Lens antenna-9.19.2

14.3 Value of radius and angle (θ) of nonmetallic Dielectric Lens-9.19.3

14.4 Feeding system of lens antenna.-9.19.4

14.5 Merits and demerits of Lens antenna-9.19.6

14.6 Value of index of refraction (µ) and radius (r) of E-plane metal plate Lens antenna-9.19.7

**[Lecture 19th]**

15.1 **Horn antenna**-(Physical Structure, Operating principle, Radiation pattern, uses)-9.7, 9.7.1

15.2 Value of axial length L, flare angle-9.7

15.3 How improves the directivity and reduce the diffraction? 9.7

**[Lecture 20th]**

16.1 Balance to Unbalance Transformation-10.33

16.2 Baluns-10.34

16.3 Balance and Unbalance Lines-10.35

**Problems :** Examples 7.1, 7.11, 7.12, 7.15, 7.17 , 8.2 to 8.9, 8.15, 9.4, 9.5, 9.9 to 9.14

**References :**

1. Antenna Theory Analysis and Design – Balanis
2. Antenna and Wave Propagation – K D Prasad

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