NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ELECTRICAL AND ELECTRONICS ENGINEERING

TELECOMMUNICATIONS ENGINEERING PROGRAM

EE525 – ANTENNAS

I. GENERAL INFORMATION

CODE	**:**	EE525 – Antennas
SEMESTER	**:**	8
CREDITS	**:**	03
HOURS PER WEEK	**:**	04 (Theory – Practice)
PREREQUISITES	**:**	EE524 – Electromagnetic Propagation and Radiation II
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The course gives the student a basic and general view of the phenomenon of electromagnetic radiation, defining the basic parameters used to specify such radiation and presenting the most commonly used types of antennas.

III. COURSE OUTCOMES

At the end of the course the student will:

- Know the fundamentals of radiation (radiation parameters, behavior as a receiving antenna, transmission equation, etc.).

- Describe the types of antennas and the interaction between electromagnetic waves and the environment (effects of the ground of the troposphere, ionosphere and receiver mobility).

IV. LEARNING UNITS

1. INTRODUCTION
Antenna definition. Radio frequency bands. Types of antennas. Maxwell equation and boundary conditions. Current distribution. Radiation mechanism. Poynting theorem and performance. Field quantities and units.

2. FIELDS RADIATED BY AN ANTENNA
Delayed Potentials. Radiation of a current element. Concept of wave and wavelength. Radiation from real sources. Radiation fields of an antenna

3. BASIC RADIATION PARAMETERS
Input impedance. Irradiation diagram. Types of diagrams. Radiation diagram parameters. Intensity of radiation. Definition of directivity and approximate expressions. Gain. Polarization. Bandwidth.

4. ANTENNAS
The antennas as efficient radiant systems. Radiation intensity and radiated power. Parameters of an antenna: Radiation resistance, directivity, gain, lobe width B, useful or effective aperture, point isotropic source (fpi). Fpi systems or arrangement; lateral

(breadside) longitudinal arrangement (endfire). Principle of multiplication of radiation patterns, element factor and arrangement factor. Examples.

5. LINEAR AND OPENING ANTENNAS

The balanced dipole of λ / 2; parameter of the dipole λ / 2, the monopole of λ / 4 on the conductor plane. Long wire antennas (resonant and non-resonant). Terrain Effect. Impedance of an antenna. The biconic antenna (Schelkunoff) own and mutual impedances; use of diagrams. Practical opening antennas; horn, reflector, parabolic and grooves.

6. THE HALF WAVE DIPOLE IN THE FREE SPACE

Distribution of voltages and currents. Calculation of the radiation field. Resonance. Input impedance. Long antennas. Multiples of half wavelength.

7. SOIL EFFECTS

The image principle. Horizontal antennas. Vertical antennas. Effects of soil conductivity.

8. ANTENNESS ARRANGEMENT

Definition. Arrangement of two elements. The Yagui antenna. Parasitic elements. Arrangement of long antennas. Multiple dipole arrangement. Beam sweep by phase change. Parabolic reflectors, lenses. waveguide and slot feeder type feeders. Broadband antenna. Dipole modification, additional broadband radiators. Small loop antennas Helical antennas Logarithmic antennas.

9. PROPAGATION IN THE GROUND ENVIRONMENT

Earth reflection coefficient. Reflections on spherical earth. Radio direct vision links in the presence of land. Earth roughness effects. Diffraction on obstacles in the field. Propagation by surface wave.

10. EFFECT OF THE TROPOSPHERE

Description of the troposphere refraction. Duct effect. Attenuation of gases and hydrometeors. Tropospheric dispersion.

11. EFFECTS OF THE IONOSPHERE

Description of the ionosphere. Propagation in an ionized medium. Influence of the Earth's magnetic field. Ionospheric propagation models.

12. PROPAGATION FOR MOBILE

Slow fades Receiver mobility, frequency dispersion and rapid fades over time. Multipath propagation, temporal dispersion and frequency fades. Solutions to reduce its effects.

V. METHODOLOGY

The course takes place in theory and practice sessions. In the theory sessions the professor presents the concepts, and the analysis of antennas and their applications in telecommunications. In the practical sessions, different antenna problems and their various applications are presented and solved. In all classes the active participation of the student is promoted both in the analysis and in the solution of problems.

VI. EVALUATION FORMULA

The learning will be evaluated through the "F" system:

- Midterm Exam (ME): weights as 1
- Final Exam (FE): weights as 2
- Average of Quizzes (Q): weights as 1

The final grade (FG) is obtained as follows:

$$\boldsymbol{FG} = \frac{\boldsymbol{ME} + \mathbf{2} * \boldsymbol{FE} + \boldsymbol{Q}}{\mathbf{4}}$$

VII. BIBLIOGRAPHY

- "Antenna Theory: Analysis and Design", Constantine A. BWSTM, 2009.
- “Antennas and Wave Propagation”, G.S.N. Raju. Pearson Education, 2006.
- “Antenna Theory and Microstrip Antennas”, D. G. Fang. CRC Press, 2017.