

HIGHER TECHNICAL INSTITUTE

ELECTRICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

**ANTENNAS
(YAGI ANTENNA)**

E.1368

GEORGE XENOPHONTOS

JUNE 2004

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Project report: **Antennas (Yagi Antenna)**

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Summary

The purpose of this work is to get familiar with Aerials in general and to study the basic fundamental principles of antenna theory and the different basic types of them. Some popular and frequently used antenna structures will be introduced while looking to their characteristics, shape, design and properties.

With the work, also some laboratory experiments will be combined, using the laboratory equipment provided, which is the "Antenna Training System Data Acquisition" and "Management Software – LVDAM-Antennas" of LAB-VOLT. Simulations of the most basic aerial types will be performed, obtaining their radiation patterns, as well as of the Yagi-Uda type aerial, which is the one that the work is interested in and its design will be studied.

Also a small and simple computer program found will be used for the optimum design of several Yagi aerials and with reference to other ways of designing this type of aerials, comparisons will be made to conclude at the factors that influence their physical dimensions in order to obtain the best design.

Introduction - Antenna and History

The history of antennas dates back to James Clerk Maxwell who unified the theories of electricity and magnetism, and eloquently represented their relations through a set of profound equations best known as Maxwell's Equations. His work was first published in 1873. He also showed that light was electromagnetic and that both light and electromagnetic waves travel by wave disturbances of the same speed. In 1886, Professor Heinrich Rudolph Hertz demonstrated the first wireless electromagnetic system. He was able to produce in his laboratory at a wavelength of 4 meters a spark in the gap of a transmitting $\lambda/2$ dipole which was then detected as a spark in the gap of a nearby loop. It was not until 1901 that Guglielmo Marconi was able to send signals over large distances. He performed, in 1901, the first transatlantic transmission from Poldhu in Cornwall, England, to St. John's Newfoundland. His transmitting antenna consisted of 50 vertical wires in the form of a fan connected to ground through a spark transmitter. The wires were supported horizontally by a guyed wire between two 60-m wooden poles. The receiving antenna at St. John's was a 200m wire pulled and supported by a kite. This was the dawn of the antenna era.

From Marconi's inception through the 1940s, antenna technology was primarily centered on wire related radiating elements and frequencies up to about UHF. It was not until World War II that modern antenna technology was launched and new elements (such as waveguide apertures, horns, reflectors) were primarily introduced. A contributing factor to this new era was the invention of microwave sources (such as the klystron and magnetron) with frequencies of 1 GHz and above.

While World War II launched a new era in antennas, advances made in computer architecture and technology during the 1960s through the 1990s have had a major impact on the advance of modern antenna technology, and they are expected to have an even greater influence on antenna engineering into the twenty-first century. Beginning primarily in the early

1960s, numerical methods were introduced that allowed previously intractable complex antenna system configurations to be analyzed and designed very accurately. In addition, asymptotic methods for both low frequencies (e.g., Moment Method (MM), Finite-Difference, Finite-Element) and high frequencies (e.g., Geometrical and Physical Theories of Diffraction) were introduced, contributing significantly to the maturity of the antenna field. While in the past antenna design may have been considered a secondary issue in overall system design, today it plays a critical role. In fact, many system successes rely on the design and performance of the antenna. Also, while in the first half of this century antenna technology may have been considered almost a "cut and try" operation, today it is truly an engineering art. Analysis and design methods are such that antenna system performance can be predicted with remarkable accuracy. In fact, many antenna designs proceed directly from the initial design stage to the prototype without intermediate testing. The level of confidence has increased tremendously.

The widespread interest in antennas is reflected by the large number of books written on the subject. These have been classified under four categories: Fundamental, Handbooks, Measurements, and Specialized. This is an outstanding collection of books, and it reflects the popularity of the antenna subject, especially since the 1950s.