UNIVERSITÀ DI PAVIA

## Anno Accademico 2021/2022

# ANTENNAS AND PROPAGATION

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| **Enrollment year** | 2020/2021 |
| **Academic year** | 2021/2022 |
| **Regulations** | DM270 |
| **Academic discipline** | ING-INF/02 (ELECTROMAGNETIC FIELDS) |
| **Department** | DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING |
| **Course** | ELECTRONIC ENGINEERING |
| **Curriculum** | Photonics |
| **Year of study** | 2° |
| **Period** | 1st semester (27/09/2021 - 21/01/2022) |
| **ECTS** | 9 |
| **Lesson hours** | 80 lesson hours |
| **Language** | English |
| **Activity type** | ORAL TEST |
| **Teacher** | BOZZI MAURIZIO (titolare) - 9 ECTS |
| **Prerequisites** | The course requires students to know the electromagnetic radiation theory, the geometrical optics and the theory and techniques for the analysis of high frequency circuits. |
| **Learning outcomes** | The course aims to introduce the fundamental principles of antenna theory and to present, in a unified manner, the analysis, design, and measurements of antennas. The most common antenna configurations are introduced, such as linear dipoles, loops, arrays, horn antennas, microstrip antennas, and reflector antennas. Moreover, the basic concepts of integrated antennas, antennas for mobile communications and RFID systems and ultrawide-band (UWB) applications are presented. Fundamentals of antenna measurements are briefly discussed. Furthermore, the course provides information on the most common simulation tools for the antenna analysis and design. A number of hours of practical classes will be spent to this end: during these hours, |

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| | students can design simple antenna structures, by using dedicated software tools.<br><br>The course will be taught in English. |
| **Course contents** | Part 1: ANTENNAS<br>Basic concepts<br>Transmitting antennas: radiation pattern, input parameters, radiation efficiency, directivity, gain, bandwidth, polarization of the radiated field.<br>Receiving antennas: reciprocity, effective area, polarization loss, antenna noise temperature.<br>Simple radiators<br>Dipoles, loops, slots, patches, open ended waveguides, horn antennas.<br>Aperture-type antennas<br>Parabolic reflector antennas, aperture efficiency: illumination-, polarization-, phase-, blockage-, spillover-, surface tolerances- and losses-efficiency. Cassegrain and Gregorian antenna systems, offset reflector antennas.<br>Arrays<br>Array factor, mutual coupling, feeding networks, synthesis of the radiation pattern of uniform linear arrays, uniform two-dimensional planar arrays and the infinite array model.<br>Other types of antennas<br>Travelling-wave antennas, leaky-wave antennas, integrated antennas, smart antennas, antennas for RFID systems and UWB antennas.<br>Antenna measurements<br>Measurement of gain and radiation pattern. Open space and anechoic chamber. Near-field and far-field measurement.<br><br>Part 2: PROPAGATION<br>Basic concepts<br>Effect of terrain and atmosphere on radio wave propagation. Antennas on flat Earth and spherical Earth. Surface waves, obstacle diffraction, and ionospheric reflection. Coverage diagrams.<br>Ionospheric propagation<br>Ionospheric propagation. Effect of Earth’s magnetic field. Faraday rotation. Minimum skip distance and maximum usable frequency.<br>Atmospheric propagation<br>Attenuation by rain, fog, snow and ice, and atmospheric gases. Scattering by rain. Tropospheric scatter propagation. Atmospheric ducts and nonstandard refraction. |
| **Teaching methods** | Lectures: 54 hours<br>Lab activities: 26 hours |
| **Reccomended or required readings** | C. A. Balanis. Antenna Theory - Analysis and Design. John Wiley and Sons, Inc, 2005.<br>R.E. Collin. Antennas and radiowave propagation. McGraw-Hill, 1985.<br>Notes from the course instructor. |
| **Assessment methods** | The final test consists on a oral examination. Each student can present a simple antenna design, implemented by the tools introduced during the practical classes, as a basis for the examination discussion. |

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| **Further information** | = |
| **Sustainable development goals - Agenda 2030** | $lbl_legenda_sviluppo_sostenibile |