



## GENERAL INFORMATION

### Data of the subject

|                   |  |
|-------------------|--|
| Subject name      | Electromagnetic Waves  |
| Subject code      | DEA-GITT-314   |
| Main program      | <a href="#">Bachelor's Degree in Engineering in Telecommunication Technologies</a> |
| Involved programs | Grado en Ingeniería en Tecnologías de Telecomunicación [Third year]                |
| Quarter           | Semestral  |
| Credits           | 6,0 ECTS   |
| Type              | Optativa (Grado)   |
| Department        | Department of Electronics, Control and Communications                              |
| Coordinator       | Pedro Olmos González   |
| Office hours      | Ask teacher before or after class  |

### Teacher Information

#### Teacher

|            |   |
|------------|---|
| Name       | Pedro Celestino Olmos González                        |
| Department | Department of Electronics, Control and Communications |
| EMail      | pedro.olmos@icai.comillas.edu                         |

#### Profesores de laboratorio

#### Teacher

|            |   |
|------------|---|
| Name       | Francisco Javier Herraiz Martínez                     |
| Department | Department of Electronics, Control and Communications |
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## DESCRIPTION OF THE SUBJECT

### Contextualization of the subject

#### Prerequisites

Prior knowledge required for student are the following: Electromagnetic fields, complex algebra, differential and integral calculus. Energy and electromagnetic power, resonance. Logarithmic units: decibel. Circuits analysis and frequency response.

## Course contents

### Contents



## **Part 1: Transmission lines**

The basic lines contained in the program are articulated around the fundamental concepts of electromagnetism.

### **Topic 1: Transmission lines**

- 1.1 Transmission lines equations.
- 1.2 Line impedance
- 1.3 Reflection.
- 1.4 "S" parameters.
- 1.5 Smith char. Impedance matching using Smith char, lumped and distributed elements.
- 1.6 More common lines types; coaxial, bifilar, microstrip, stripline.

## **Part 2: Ondas guiadas.**

### **Topic 2: Waveguides.**

- 2.1 Wave equation resolution, electromagnetic resolution of transmission lines equations. Propagation modes.
- 2.2 Wave velocity. Phase and group velocity.
- 2.3 Rectangular waveguide.
- 2.4 Circular waveguide .
- 2.5 Coaxial waveguide , Upper modes.
- 2.6 Cavity and resonators.

## **Part 3: Free space waves.**

### **Topic 3: Plane waves.**

- 3.1 Uniform plane waves in free space. (Just a little review)
- 3.2 Plane waves polarization (Just a little review)
- 3.3 Plane waves in lossy medium.
- 3.4 Boundary conditions.
- 3.5 Reflection in dielectric medium.

### **Topic 4 :Radiación.**

- 4.1 Spheric waves esféricas. Transmission basic equation. Link loss and depolarization.
- 4.2 Ground influence Reflection, diffraction, ground wave etc.
- 4.3 Atmospheric influence. Refraction. Atmospheric gases losses, water vapor, rain etc.
- 4.4 Ionospheric propagation. Faraday rotation.
- 4.5 Other types of propagation.

## **Part 4: Antennas.**

### **Topic 5: Antennas**

- 5.1 Basic concepts of antennas. Most important parameters.
- 5.2 Short antennas, short dipole and small loop.
- 5.3 Lineal antennas .
- 5.4 Arrays
- 5.5 Wide band antennas .
- 5.6 Aperture antennas, horns and parabolic. (2)
- 5.7 Diversity, smart antennas and MIMO system.

## **Part 5: Laboratory practices.**



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**Syllabus**  
**2025 - 2026**

Practice 0: Learning and familiarization with radio frequency simulation programs.

Practice 1: Vector network analyzer and S parameters. Transmission lines

Practice 2: Antennas. Design, simulation and construction of an antenna using moments method and its measurement in the laboratory.

## EVALUATION AND CRITERIA

The use of AI to produce full assignments or substantial parts thereof, without proper citation of the source or tool used, or without explicit permission in the assignment instructions, will be considered plagiarism and therefore subject to the University's General Regulations.

| Evaluation activities | Evaluation criteria  | Weight |
|-----------------------|--|--------|
| Laboratory practices. | Compression of concepts.<br><br>Application of concepts to the resolution of practical problems.<br><br>Skilled in problem solving with the help of the appropriate laboratory material and specific software.<br><br>Analysis and interpretation of the results obtained in the problems solved with a computer.<br><br>Group work capacity.<br><br>Presentation and written communication. | 10     |
| Final test            | Understanding of concepts.<br><br>Application of concepts to the resolution of practical problems.<br><br>Analysis and interpretation of the results obtained in solving problems.<br><br>Presentation and written communication   | 60     |
| Intersemestral test   | Application of concepts to the resolution of practical problems<br><br>Presentation and communication in writing and in graphics mode.   | 20     |



Problems with S-parameter microwave simulators.  
(Practice 0)

Correctly solve the proposed problem with the help of radiofrequency simulation programs, imaginative or ingenious solutions will also be valued

10

## Grading

The qualification in the **ordinary test** of the subject will be obtained as:

60% of the final exam grade. To pass the subject, a minimum grade of 5 will be required in the final exam. It will consist of two parts, theory and practice. To pass in average, you will need at least 3.5 points in each of the parts.

20% the inter-semester exam

10% laboratory works

10% individual works (práctica 0).

The grade in the **extraordinary test** for the subject will be obtained as:

80% of the mark of the extraordinary final exam. To pass the subject, a minimum grade of 5 will be required in said exam.

10% of laboratory work.

10% individual work (practice 0).

Students who have failed the subject and obtained a grade lower than 3.5 both in the laboratory or in the individual works will be examined in an extraordinary session.

## WORK PLAN AND SCHEDULE

| Activities  | Date of realization | Delivery date |
|---|---------------------|---------------|
| Reading and study of the theoretical contents in the notes            | After every class   |               |
| Resolution of the proposed problems.                                  | Weekly              |               |
| Delivery of the proposed problems.                                    |                     | Next week     |
| Preparation of the tests that will be carried out during class hours. | After each topic    |               |
| Delivery of individual works (practice 0).                            | Entire course.      | December 31   |
| Preparation of the Final Exam.  | December            |               |



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## Syllabus 2025 - 2026

Preparation of laboratory reports.

15 days after each practice

## BIBLIOGRAPHY AND RESOURCES

### Basic References

- Introduction to RF Propagation. John S. Seybold, Ph.D. Ed: John Wiley & Sons, Inc.,
- Electromagnetic Waves and Antennas. Sophocles J. Orfanidis, ECE Department.
- Rutgers University. <http://www.ece.rutgers.edu/~orfanidi/ewa>
- Propagation of radio waves. M. Dolukhanov. Moscú 1995.
- Antenna theory. Analysis and design. Constantine A. Balanis.
- Antenna Physics: An introduction. Robert J. Zavrel, W7SX. ARRL.
- Radio System Design for Telecommunications (1-100 GHz). Roger L. Freeman. Ed: John Willey and Sons inc.

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