

## Microwave Engineering

Code: 102703  
ECTS Credits: 6

2024/2025

| Degree  | Type | Year |
|---|------|------|
| 2500898 Telecommunication Systems Engineering | OT   | 4    |

### Contact

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### Teachers

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### Teaching groups languages

You can view this information at the [end](#) of this document.

### Prerequisites

There is not precondition

### Objectives and Contextualisation

In wireless communication systems the channel is an asset shared by different users and / or by different communication services. In this sense, communications systems use the electromagnetic spectrum in high frequency.

The subject of Microwave Engineering is focused on the design of specific components for the RF and Microwave communication equipment. Objectively, it deals with providing the knowledge to understand theoretical phenomena, and practical experiences, of application in the development of hardware and simulation software in industrial projects with needs of both the space segment (telecommunication, navigation, earth observation and space sciences), as well as wireless terrestrial communications systems, whether wireless fixed as mobile.

Microwave engineering provides key tools to face technological challenges such as the design of radio frequency components and subsystems, for both terminal equipment and radio communications base stations. Requirements and technologies, factors for miniaturization.

The more detailed objectives are presented in the following list, so we consider that the student at the end of the course will be able to:

- Use tools for analysis and synthesis of devices and subsystems in the radio frequency and microwave bands, as well as to introduce the most widely used technologies in high frequency.

- Manage the formulation of scattering parameters as a tool for synthesis and analysis of devices in high frequency. As well as the fundamental properties.
- Analyze and design passive devices of n-ports, by means of the techniques provided, present in a RF-FEM (Radio Frequency-Front End Module): attenuators, dividers, couplers, resonators, modulators.
- Design linear and nonlinear devices based on active elements (switch, limiters, mixers, amplifiers)
- Express the conclusions of the work in the appropriate technical language.

## Competences

- Communication
- Develop personal attitude.
- Develop thinking habits.
- Draft, develop and sign projects in the field of telecommunications engineering that, depending on the speciality, are aimed at the conception, development or exploitation of telecommunication and electronic networks, services and applications.
- Learn new methods and technologies, building on basic technological knowledge, to be able to adapt to new situations.
- Select and devise communication circuits, subsystems and systems that are guided or non-guided by electromagnetic, radiofrequency or optical means to fulfil certain specifications.

## Learning Outcomes

1. Analyse and design radiofrequency, microwave, broadcasting, radio-link and radio-determination antennas, circuits, subsystems and systems.
2. Communicate efficiently, orally and in writing, knowledge, results and skills, both professionally and to non-expert audiences.
3. Design radio communication based applications, understood to be systems for receiving and transporting information.
4. Develop curiosity and creativity.
5. Develop systemic thinking.
6. Develop the capacity for analysis and synthesis.
7. Generate innovative and competitive proposals in professional activity.
8. Manage information by critically incorporating the innovations of one's professional field, and analysing future trends.
9. Use specific simulation tools to analyse and design radiofrequency telecommunication applications.

## Content

1. TRANSMISSION LINE.

2. GEOMETRIES OF THE TRANSMISSION LINE.

Planar transmission line, STRIPLINE.

Planar transmission line, MICROSTRIP.

3. MATRIX REPRESENTATION MICROWAVE CIRCUITS.

Scattering parameters.

Relationship between parameters  $s$ ,  $z$  and  $y$ .

Properties of the scattering matrix.

Parameters [s] in networks with symmetry plane.

Power transfer gain. Voltage gain and scattering parameters.

Two ports passive networks.

Lossless passive networks.

Scattering parameter of transmission line.

#### 4. PASSIVE MICROWAVE CIRCUITS.

Attenuators

Three ports passive networks (i).

Circulator

Resistive dividers.

Dividers using transmission lines

Wilkinson's divider.

Four-port networks (directional coupler).

Hybrid of  $90^\circ$ .

Hybrid of  $180^\circ$ .

General applications

Operation as phase detector.

Four ports networks with coupled lines.

Analysis with edge coupling.

Microwave resonators

### Activities and Methodology

| Title                           | Hours | ECTS | Learning Outcomes |
|---------------------------------|-------|------|-------------------|
| Type: Directed                  |       |      |                   |
| Problem seminars                | 15    | 0.6  | 6                 |
| Session Labs                    | 10    | 0.4  | 9                 |
| Theoretical classes             | 30    | 1.2  | 1, 3, 6           |
| Type: Supervised                |       |      |                   |
| Lab tutorship                   | 5     | 0.2  |                   |
| Microwave Engineering Tutorship | 13    | 0.52 | 4                 |
| Type: Autonomous                |       |      |                   |

|                                |    |     |      |
|--------------------------------|----|-----|------|
| Individual study               | 30 | 1.2 | 3, 5 |
| Lab Practicum review           | 10 | 0.4 | 2, 9 |
| Problem solving and case study | 15 | 0.6 | 6    |

The following training activities will be developed:

- Theory lessons where the main concepts of the subject will be explained, including examples and Applications.
- Practical problem classes where the emphasis will be placed on procedural aspects in the resolution of questions.
- Laboratory classes where the practical experimentation of the concepts developed in theoretical class.

The lessons of theory and problem solving will take place simultaneously on the blackboard and with slides.

Students will be provided with a collection of problems prior to their resolution in the class.

The professor will receive the students in his office during the specified tutoring hours, in order to solve doubts, develop concepts, etc.

It is highly recommended to attend these tutorials for better use of the course.

It will be ensured that all the material is available to students through the Campus Virtual.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Assessment

### Continous Assessment Activities

| Title             | Weighting | Hours | ECTS | Learning Outcomes |
|-------------------|-----------|-------|------|-------------------|
| EXAM 1            | 30 %      | 1.5   | 0.06 | 1, 3, 5, 6        |
| EXAM 2            | 30%       | 1.5   | 0.06 | 1, 2, 3, 5, 6     |
| Lab Practicum     | 30%       | 15    | 0.6  | 1, 4, 8, 9        |
| Lab exam          | 10%       | 1     | 0.04 | 1, 7, 9           |
| REEVALUATION EXAM | 60 %      | 3     | 0.12 | 3, 5, 6           |

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## Bibliography

## Basic References

### Microwave Engineering

D.M. Pozar, Adison Wesley, 2011.4th edition, ISBN:0-471-44878-8

### Consulting Referenes

#### Circuits de Microones amb Línies de Transmissió

J. Bará, Edicions UPC, 1993.

#### Microstrip Filtres for RF/Microwave Applications

Jia-Sheng HONG, M. J. Lancaster, John wiley & sons, ISBN 0-471-22161-9

#### RF and Microwave Coupled-Line Circuits

R. K. Mongia, I. J. Bahl, P. Bhartia, J. Hong, Artech House, 2007, Second Edition, ISBN: 978-1-59693-156-5

#### Microwave Solid State Circuit Design

I. Bahl, P. Bhartia, John Wiley, 1988

## Software

Advanced Design System, ADS by Keysight

## Language list

| Name                          | Group | Language | Semester       | Turn          |
|-------------------------------|-------|----------|----------------|---------------|
| (PAUL) Classroom practices    | 331   | Spanish  | first semester | morning-mixed |
| (PLAB) Practical laboratories | 331   | Spanish  | first semester | morning-mixed |
| (TE) Theory                   | 330   | Spanish  | first semester | morning-mixed |