Course guide
230470 - ONEMAG - Electromagnetic Waves

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2022   ECTS Credits: 6.0   Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Foundations on Electricity and Magnetism, both in free space and in dielectric and magnetic media. Waves, vectorial analysis and ordinary differential equations

REQUIREMENTS

The course of Electromagnetism.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge of electromagnetism laws. Ability to solve engineering problems: magnetism, electricity and electrical technology, electromagnetic waves and wave optics.
2. Knowledge of the mechanisms of propagation and transmission of electromagnetic waves. Ability to analyze and use transmitter and receiver devices.

Generical:
1. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:
2. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

It is developed mainly through lectures, sometimes with prepared presentations, and also through visualization of computer simulations.
Analysis and simulation work is proposed so that students can verify and visualize the phenomena described in lectures. All the contents can be found at the Atena page.
LEARNING OBJECTIVES OF THE SUBJECT

The main goal is to provide students with a clear, visual, and mathematical, understanding of the phenomena associated with wave propagation in free space and through transmission lines of any type.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Self study</td>
<td>85,0</td>
<td>56.67</td>
</tr>
<tr>
<td>Hours large group</td>
<td>65,0</td>
<td>43.33</td>
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</tbody>
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Total learning time: 150 h

CONTENTS

1. Electromagnetic waves in free space

Description:
1.1 Wave equation. Wave functions.
1.2 Plane waves and spherical waves.
1.3 Plane waves in steady sinusoidal state. Uniform and non-uniform plane waves. Wave impedance.
1.4 Power and power density associated with the wave.
1.5 Polarization. Types of polarization. Elements for the control of polarization: polarizer and retarder plates.
1.6 Plane waves in lossy media.

Full-or-part-time: 30h
- Theory classes: 7h
- Practical classes: 5h
- Guided activities: 2h
- Self study: 16h

2. Incidence of waves in separation surfaces

Description:
2.2 Total reflection.
2.3 Standing waves. Totally and partially standing waves. Standing wave ratio. Anti-reflection coatings.

Full-or-part-time: 30h
- Theory classes: 7h
- Practical classes: 5h
- Self study: 18h
3. Transmission lines  
**Description:**
3.1 Introduction: problems in circuit theory associated to high frequencies. Necessity of a new formulation. Types of transmission lines  
3.2 TEMz waves in a transmission line of two conductors. Telegraphist’s equation  
3.3 Model of distributed parameters. Circuit parameters per unit length.  
3.4 Wave propagation in a transmission line. Propagation velocity and characteristic impedance.  
3.5 Terminated transmission line without losses. Reflection coefficient, standing wave ratio and input impedance. Smith chart.  
3.6 Generator and load mismatching. Power transmission and conjugated impedance matching.  
3.7 Losses in transmission lines.  
**Full-or-part-time:** 26h  
Theory classes: 7h  
Practical classes: 4h  
Guided activities: 1h  
Self study : 14h

| 4. Waveguides and optical fibers  
**Description:**  
4.1 Waveguides with conducting walls  
4.2 Rectangular conducting waveguides  
Propagation modes. Dispersion curves. Transmitted power  
4.3 Resonators  
4.4 Plane dielectric waveguides  
Guided and radiation modes  
**Full-or-part-time:** 32h  
Theory classes: 9h  
Practical classes: 5h  
Self study : 18h |

| 5. Foundations of radiation  
**Description:**  
5.1 Antenna parameters and transmission equation.  
5.2 Radiated and induced fields.  
5.3 Far field approximation. Significance of the radiation vector.  
5.4 Elemental antennas: electric and magnetic dipoles  
5.5 Images theory  
5.6 Antenna arrays  
**Full-or-part-time:** 32h  
Theory classes: 9h  
Practical classes: 5h  
Self study : 18h |
GRADING SYSTEM

The final mark is given by three figures: the final exam (EF), the middle term exam (EP) and the evaluation of specific works realized during the course (TE).

The final mark is given by: Max \{0.90 \times EF + 0.10 \times TE, 0.55 \times EF + 0.35 \times EP + 0.10 \times TE \}

In the case of having to go to the extraordinary exam, the note of this will also be averaged with the note of the works, which are not re-evaluated. That is, the final qualification would be in this case
\{0.90 \times ExExtra + 0.10 \times TE \}

EXAMINATION RULES.

There is an ‘official’ formula sheet for the subject, drawn up by course teachers, which can be used during exams. Annotations can NOT be added to that form.

BIBLIOGRAPHY

Basic:

Complementary: