

Course guide 300025 - OESC - Electromagnetic Waves in Communication Systems

Unit in charge: Teaching unit:	Last modified: 01/06/2023 Castelldefels School of Telecommunications and Aerospace Engineering 739 - TSC - Department of Signal Theory and Communications.
Degree:	BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Compulsory subject). BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).
Academic year: 2023	ECTS Credits: 7.5 Languages: Catalan, Spanish

LECTURER	
Coordinating lecturer:	Definit a la infoweb de l'assignatura.
Others:	Definit a la infoweb de l'assignatura.

PRIOR SKILLS

Before starting the subject, the student must be able to:

 \cdot Obtain, from the graphical representation in the time domain of a sinusoidal voltage, its amplitude (peak value and effective value), frequency and phase and vice versa.

· Express analytically or graphically (in the time domain) the sum of two sinusoidal voltages of the same frequency.

· Define the concept of available power of a sinusoidal generator and calculate its value from its internal voltage and impedance.

· For a circuit formed by a sinusoidal generator with complex internal impedance connected to a also complex load, calculate:

or the values $\hat{a} \square \hat{a} \square \hat{a} \square \hat{a} \square$ of the complex amplitudes of the voltage and current at the load and graphically represent them in the complex plane.

o The instantaneous values $\hat{a} \square \hat{a} \square \hat{a} \square$ (expressions in the time domain) of the voltage and current in the load

or the average power delivered in the load.

• Perform operations with complex numbers (addition, subtraction, product, quotient, modulus, phase, real and imaginary part, powers, roots) with the help of calculators or mathematical software.

 \cdot Make an oral presentation, respond appropriately to the questions asked and write a basic level report with spelling and grammar correction.

• Define the objectives and operating rules of the group, carrying out regular monitoring and review. Actively participate in group work, once individual responsibilities and tasks have been defined. Share information and results. Jointly decide on the strategy to follow.

 \cdot Directed learning: Carry out the tasks assigned in the scheduled time, working on the sources of information indicated according to the guidelines set by the teachers. Identify learning problems and deficiencies.

· Correctly use the instruments, equipment and software of the basic electronics laboratory (power supply, multimeter, function generator and oscilloscope). Carry out the proposed experiments and practices and analyze the results obtained.

REQUIREMENTS



DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

1. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

2. CE 9 TELECOM. Capacidad de analizar y especificar los parámetros fundamentales de un sistema de comunicaciones.(CIN/352/2009, BOE 20.2.2009.)

Generical:

5. PROJECT MANAGEMENT - Level 2: Define the objectives of a well-defined, narrow scope, and plan development, identifying resources, tasks, shared responsibilities and integration. Use appropriate tools to support project management.

7. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 2: Use the correct instruments, equipment and laboratory software for specific or specialized knowledge of their benefits. A critical analysis of the experiments and results. Correctly interpret manuals and catalogs. Working independently, individually or in groups, in the laboratory.

Transversal:

3. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

4. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

6. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

Taking into account the thematic breadth of the contents, in the most theoretical parts the logical rigor of the discipline is maintained, but much of the formal rigor is renounced in favor of the interpretation of phenomena and their applications, so that the demonstrations Mathematics is restricted to those cases in which they provide significant information by themselves.

LEARNING OBJECTIVES OF THE SUBJECT

This course is mainly concerned with the mechanisms of propagation and transmission of waves and the limits of its contents take into account that the specific competence "Ability to analyze and specify the fundamental parameters of a communications system" works in coordination with the FC subject and The competence "Ability to understand the mechanisms of propagation and transmission of electromagnetic and acoustic waves, and their corresponding emitting and receiving devices" works in parallel with the EiR subject "Ability to understand the mechanisms of propagation and transmission of electromagnetic and acoustic waves, and their corresponding emitting and receiving devices."

The student's training, and therefore its evaluation, are oriented not only towards learning the essential knowledge and skills related to specific competences, but also towards the acquisition and development of generic or transversal competences of effective oral and written communication, Teamwork, autonomous learning, efficient use of instrumentation equipment and project management.

Given the thematic breadth of the contents, in the most theoretical parts the logical rigor of the discipline is maintained, but much of the formal rigor is renounced in favor of the interpretation of phenomena and their applications, so that mathematical proofs are restrict to those cases in which they provide significant information by themselves. These theoretical parts are complemented by the completion by the students of small practical projects that will reveal various phenomena related to waves.

The observance of the regulations generated by the School, the follow-up of its recommendations and the success of the strategies developed are three of our quality objectives, although the main objective is the satisfaction of our students and other stakeholders, satisfaction that will be achieved if we manage to get as many students as possible to enroll in the subject to overcome it in time and with the expected workload and that their training is adequate and satisfactory.

To achieve these objectives, the teaching team of the subject has designed a teaching-learning process that includes a program of activities that requires regular dedication by the student throughout the course and that shifts the learning process towards working methods. in team (or cooperative work), so that all the student members assume the double responsibility of their personal learning and that the team or group reaches the proposed objectives. For this reason, it is necessary that all the components of the group are aware of what specific activities and behaviors are expected of them, commit to assume them and strive to maintain the commitment.

The relationship of the learning objectives can be seen in the Activities section.



STUDY LOAD

Туре	Hours	Percentage
Self study	105,0	56.00
Hours large group	52,5	28.00
Guided activities	30,0	16.00

Total learning time: 187.5 h

CONTENTS

PRESENTATION OF THE SUBJECT

Description:

- Organization of the subject and teaching methodology.

- Course folder and cooperative work.
- Evaluation system.

Full-or-part-time: 4h 30m Theory classes: 3h Guided activities: 0h 30m Self study : 1h

SINUSOIDAL SIGNALS AND POWER IN PERMANENT SINUSOIDAL REGIME

Description:

Sine wave signals: characteristic parameters and mathematical expressions Graphic representations. Scilab software.

Powers in permanent sinusoidal regime: average power and available power of a generator. Relation between the power delivered by a generator and its available power

Full-or-part-time: 8h Self study : 8h

TRANSMISSION LINES

Description:

- Voltage and current in a transmission line in different load situations.
- Impedance in a line.
- Powers in a transmission line.
- Attenuation in transmission lines.

Full-or-part-time: 44h Theory classes: 12h Guided activities: 6h Self study : 26h



ELECTROMAGNETIC WAVES IN SPACE: PROPERTIES (RADIATION AND PROPAGATION OF WAVES)

Description:

- Coordinates and vectors. Spherical coordinates.
- Sound waves. Pulsing sphere. Transmission equation
- Fields radiated by an elemental dipole. Radiation parameters of the elemental dipole
- Transmission equation of an antenna. Wave polarization.

Full-or-part-time: 44h Theory classes: 12h Guided activities: 6h Self study : 26h

REFLECTION, REFRACTION, DIFRACTION AND INTERFERENCE OF WAVES

Description:

- Locally flat waves. Uniform flat waves
- Normal incidence of a plane wave on a conducting plane.
- Normal incidence of a flat wave on a flat dielectric.
- Oblique flat wave
- Oblique incidence on the conductor plane
- Wave interference and diffraction.

Full-or-part-time: 43h

Theory classes: 17h Self study : 26h

INTERACTION OF WAVES WITH MATERIAL MEDIA. MEDIA WITH LOSS AND ATTENUATION.

Description:

- Complex permittivity. Film depth and attenuation
- Wave propagation in good dielectrics and good conductors
- Shielding.
- Electromagnetic fields and health

Related competencies :

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

Full-or-part-time: 4h

Theory classes: 4h



title english

Description:

- Multimode fibers: numerical openness and intermodal dispersion.
- Single-mode fiber: cut wavelength and chromatic dispersion.
- Wavelength division multiplexing. OADM (Optical Add Drop Multiplexer)

Related competencies :

. CE 9 TELECOM. Capacidad de analizar y especificar los parámetros fundamentales de un sistema de comunicaciones.(CIN/352/2009, BOE 20.2.2009.)

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

Full-or-part-time: 4h

Theory classes: 4h

WAVES PROJECT

Description:

Cooperative groups have to carry out a project that will deal with electromagnetic waves.

Each group will have to solve theoretically and experimentally the questions that are put to it.

The groups have to carry out a preliminary study (a necessary condition to do the experimental part) and make an oral presentation of the measures carried out and the results obtained.

Full-or-part-time: 36h Laboratory classes: 4h Guided activities: 6h 30m Self study : 25h 30m



ACTIVITIES

TYPOLOGY OF ACTIVITIES

Description:

There are five different typologies of activities of the subject (the activities related to the project are not included, which are described in the corresponding section):

- Powerpoint presentations: all classes are taught with powerpoint support, and the different presentations are made public to the students after the end of each class.

These powerpoints are designed in such a way that they also function as lecture notes.

Although the subject is already well established, each semester each presentation is reviewed and modifications are made. To ensure that the latest version of each presentation is used and published, the first slide of each presentation incorporates the date.

- Regular activities proposed to do in class: the theory sessions alternate explanations of the teacher with small activities (included in the powerpoints) that the students have to do, individually or in pairs. They are collected in the same class and a control is kept of who has done it (in no case may they be done or finished outside of class hours). The activities are grouped into blocks.

- Activities during personal working hours (deliverables): exercises are proposed each week that each cooperative group must deliver. For an exercise proposed for home to be considered delivered, it must meet the Quality Criteria of the resolution of an exercise and must be delivered on the date set by the teacher.

- They are returned after a week revised (not corrected), with the indication of whether it is considered delivered or not, and a solution is published with the final and intermediate results that are considered adequate (in no case will the resolution be published full exercise).

- Group control: Group controls will be carried out during class hours and no forms or notes can be served. Control no. 1 will be carried out during the first half of the term and no. 2 in the second half.

The group controls will be carried out each time by one of the members of each group chosen at random, and the grade obtained will be assigned to all the members of the group.

Each control will consist of the proposal of an exercise or parts of the different exercises proposed to be performed at home (deliverables) with modifications to their data so as not to turn them into memory exercises.

If in the draw it is the turn of an absent member to control, the whole group will be scored with a 0.

- Individual exams: The individual exams will not focus on the entire syllabus but on a reduced syllabus made up of 6 sections referring to its fundamental aspects (basic knowledge). The content and level of difficulty of the exam questions will be similar to that of the exercises and activities proposed during the course.

- A play-out of the six basic knowledge will be carried out. Students who have suspended basic knowledge, can only recover these; Students who have passed ALL basic knowledge can be presented to anyone.

If in the play-off a student obtains a lower basic knowledge grade than he already had, the highest grade will be maintained.

COOPERATIVE WORK AND COURSE FOLDER

Description:

Cooperative work is one of the pillars of the teaching methodology of the subject. The correct functioning of a working group as a cooperative group (all cooperate and commit to the success of the group and to the learning of all the components) is essential in the development of the course. For this, it is necessary that all the components are aware of the specific activities and behaviors expected of them, commit to take them on and strive to maintain the commitment.



At the beginning of the course, the teachers make a proposal for cooperative groups (groups of 3 students). This proposal is only modified if any group does not have the possibility of meeting a minimum of four hours each week of the course.

Once the composition of the cooperative groups is final, each group delivers signed deliverable 02. Group commitment, in which they must indicate the days, hours and places where they will hold their meetings.

Regardless of the monitoring that is carried out through the deliveries made, results of the evaluation acts, ..., the monitoring of the operation of each cooperative group is carried out in two ways:

- Before the mid-term exam: if a student informs the teacher of the existence of problems in his group, the teacher meets with all the members of the group urging them to try to solve the problems themselves.

- After the mid-term exam: the teacher analyzes the qualifications of the different members of each cooperative group and, in the event that there is a large discrepancy between their qualifications, restructures the groups.

The Course Folder is a concept that includes all the activities proposed to be done during class time or in personal work time.

- Regular activities proposed to do in class: they are collected in the same class and a control is kept of who has done them (in no case may they be done or finished outside of class hours). The different activities are grouped into blocks.

- Activities in personal working hours (deliverables): exercises are proposed every week that each cooperative group has to deliver. In order for an exercise proposed for home to be considered delivered, it must meet the Quality Criteria of the Resolution of an Exercise established and must be delivered on the date set by the teacher.

Once the revised (uncorrected) exercises have been returned, with the indication of whether they are considered delivered or not, a solution is published with the final and intermediate results considered appropriate (in no case will the full resolution of the exercise be published).

Deliverables made at home must be organized at the end of the course in the form of a physical ring binder or similar. If the group considers it appropriate, the folder may include a second version, which replaces or complements the exercises that have not been delivered or that have been considered as not delivered.

The portfolio evaluation criteria are established and are public from the beginning of the course.

Specific objectives:

Once this activity has been completed, the student will have improved their ability to:

- Attend meetings and respect schedules.
- Show respect for others, and pay attention when they speak or express an opinion.

- Discuss and agree, in each session, the work plan to be followed, and designate a member to act as moderator and organizer.

- Jointly discuss the difficulties encountered and the approach of each exercise or study topic.

Material:

Power Point presentation

01. Presentation of the subject

Lliurables (enunciats)

01_OESC evaluation criteria (includes rules for carrying out the different evaluation acts and the quality criteria of the exercises and the portfolio)

02_Group commitment (includes group operating rules)

Delivery:

Deliverable 01 Signed evaluation criteria. Deliverable 02 Group commitment completed and signed. Course folder (with self-assessment report folder)



Related competencies :

04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

Full-or-part-time: 4h 30m

Theory classes: 3h Guided activities: 0h 30m Self study: 1h

CONTENT ACTIVITIES SENOID SIGNALS, POWER IN RPS

Specific objectives:

- Obtain, from the graphic representation in the time domain of a sinusoidal voltage, its amplitude (peak value and effective value), frequency, period and phase and vice versa.

- Express analytically or graphically (in the time domain) the sum of two sinusoidal voltages of the same frequency.

- Carry out operations with complex numbers (module, phase, real and imaginary part, addition, subtraction, product, quotient, powers, roots) with the help of calculators and mathematical software (Scilab).

- Calculate voltages, currents, powers and impedances in circuits in RPS.

Material:

- Powerpoint presentations (include the statements of the activities to do in class)

02. Sinusoidal signals. Power in RPS

- Software

Examples of solving problems with Scilab

- Deliverables (statements and solutions)

03_Senoidal_signals and circuits in RPS_Power

Delivery: Deliverable 03 (individual)

Related competencies :

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.) 07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources. 04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical

Full-or-part-time: 8h

Self study: 8h

errors.

CONTENT ACTIVITIES TRANSMISSION LINES

Description:

The training activities of this content are classified into five groups:

Powerpoint presentations used in class: in the theory sessions the teacher's explanations (minimum essential explanations for carrying out the exercises that the cooperative groups must do weekly as part of their autonomous learning) will alternate with



activities of the students, individually or in couples.

Regular activities proposed to do in class: small activities that are collected in the same class and a control is kept of who has done them (in no case may they be done or finished outside of class hours).

Activities in personal working hours (deliverables): exercises are proposed each week that each cooperative group must deliver. They are returned after a week and a solution is published with the final results and important intermediates.

Exercise control: a control carried out by a member of each group chosen at random, and its rating is assigned to all members of the group.

Individual exam (with repechage) of basic knowledge.

Specific objectives:

Once this activity has been completed, the student will be able to:

- Calculate the voltage and current distribution (complex amplitudes and in the time domain) in a line, with or without losses, with given generator and load.

- Calculate the input impedance and return losses of a transmission line, with or without losses.

- Calculate the power flows in a line, with or without losses, with given generator and load.

- Calculate the attenuation of a line or cable from its primary parameters and perform attenuation calculations on a line with losses, both in dB's and in Nepers.

Material:

- Powerpoint presentations (include the statements of the activities to do in class)

03. Transmission lines. Voltage and current

- 04. Transmission lines. Impedance and reflection coefficient
- 05. Transmission lines. Powers
- 06. Transmission lines with losses

- Software

Examples of animations on transmission lines with Scilab

- Deliverables (statements and solutions)

04_Tension and current in a transmission line in different load situations 05_Impedances and power flows a transmission line 06_Atenuacion_lineas_transmision

- Group control (statement)

Exercise control

- Individual exam (statement)

Basic knowledge 1. Calculate the voltage and current distributions and power flows in a line section, with or without losses, with given generator and load (with complex amplitudes and in the time domain) based on the data of those .

Delivery:

Class activities: blocks 1 and 2

Deliverables 04, 05 and 06

Group control of exercises 04 to 06

Individual exam (ordinary and repechage, if necessary): Basic knowledge 1

Related competencies :

01 UEQ N2. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 2: Use the correct instruments, equipment and laboratory



software for specific or specialized knowledge of their benefits. A critical analysis of the experiments and results. Correctly interpret manuals and catalogs. Working independently, individually or in groups, in the laboratory.

. CE 9 TELECOM. Capacidad de analizar y especificar los parámetros fundamentales de un sistema de

comunicaciones.(CIN/352/2009, BOE 20.2.2009.)

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Full-or-part-time: 44h Theory classes: 12h

Guided activities: 6h Self study: 26h

CONTENT ACTIVITIES ELECTROMAGNETIC WAVES IN SPACE: PROPERTIES (RADIATION AND PROPAGATION OF WAVES)

Description:

The training activities of this content are classified into four groups:

Powerpoint presentations used in class: in the theory sessions the teacher's explanations (minimum essential explanations for carrying out the exercises that the cooperative groups must do weekly as part of their autonomous learning) will alternate with student activities, individually or in couples.

Regular activities proposed to do in class: small activities that are collected in the same class and a control is kept of who has done them (in no case may they be done or finished outside of class hours).

Activities in personal working hours (deliverables): exercises are proposed each week that each cooperative group must deliver. They are returned after a week and a solution is published with the final results and important intermediates.

Individual exam (with repechage) of basic knowledge.

Specific objectives:

Once this activity has been completed, the student will be able to:

- For a pulsating sphere and for an oscillating dipole, list, define and manage the basic concepts associated with the spherical wave: amplitude, phase, wave number, wavelength and impedance.

- Define the unit vectors in spherical coordinates, change their representation to Cartesian coordinates and relate them to the geographic coordinates.

- Transform vectors from the temporal domain to the complex and vice versa.

- State the basic properties of the fields radiated by an elemental dipole.

- Write the expression of the Poynting vector, explain its meaning and calculate power flows through finite surfaces (flat and spherical).

- Define the radiation parameters: directivity, gain, radiation diagram, EIRP, effective area, effective length and polarization and use them to calculate the relationship between received power and emitted power on a link (transmission equation).

- Graphically represent (using Scilab mathematical software) a radiation diagram from its mathematical expression and vice versa, obtain the power density at a point in space from the power radiated by an antenna and its radiation diagram.

Material:

- Powerpoint presentations (include the statements of the activities to do in class)

- 07. Coordinates and vectors. Spherical coordinates
- 08. Sound waves. Pulsing sphere. Transmission equation
- 09. Elemental dipole. Radiated fields



- 10. Elemental dipole. Radiation parameters. Transmission equation
- 11 Elemental dipole as receiver Generalization
- Deliverables (statements and solutions)
- 07_Speaker radiation parameters
- 08_Fields radiated by elemental dipole
- 09_ Radiation parameters of an antenna. Transmission equation
- 10_Receiving antennas
- Individual exam:

Basic knowledge 2. For an oscillating dipole, list, define and manage the basic concepts associated with the spherical wave: properties of radiated fields, phase, wave number, wavelength and impedance. Using the intensity of the field (electric or magnetic) created by a dipole at one point in space, find the fields created by the same dipole, located or oriented differently, at another point in space, expressing the fields in terms of Cartesian or spherical unit vectors.

Basic knowledge 3. Define the parameters of an antenna as a transmitter (impedance, directivity, gain, radiation pattern and polarization) and use them to calculate, by means of the transmission equation, the amplitude and direction of the electric field at a point in space expressed in Cartesian or spherical coordinates.

Basic knowledge 4. Define the parameters of an antenna as receiver (impedance, effective area, effective length and polarization) and the position with which you see a transmitting antenna (elevation and azimuth angles) and use them to calculate the signal strength (voltage or power) that a dipole-type receiving antenna delivers to a receiver.

Delivery:

Class activities: blocks 3 and 4

Deliverables 07, 08, 09 and 10

Control exercicis 07, 08, 09 y 10

Individual exam (ordinary and repechage, if necessary): Basic knowledge 2, 3 and 4

Related competencies :

01 UEQ N2. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 2: Use the correct instruments, equipment and laboratory software for specific or specialized knowledge of their benefits. A critical analysis of the experiments and results. Correctly interpret manuals and catalogs. Working independently, individually or in groups, in the laboratory.

. CE 9 TELECOM. Capacidad de analizar y especificar los parámetros fundamentales de un sistema de

comunicaciones.(CIN/352/2009, BOE 20.2.2009.)

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources. 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

Full-or-part-time: 44h

Theory classes: 12h Guided activities: 6h Self study: 26h

CONTENT ACTIVITIES REFLECTION, REFRACTION, DIFRACTION AND WAVE INTERFERENCE

Description:

The training activities of this content are classified into five groups:



Powerpoint presentations used in class: in the theory sessions the teacher's explanations (minimum essential explanations for carrying out the exercises that the cooperative groups must do weekly as part of their autonomous learning) will alternate with activities of the students, individually or in couples.

Regular activities proposed to do in class: small activities that are collected in the same class and a control is kept of who has done them (in no case may they be done or finished outside of class hours).

Activities in personal working hours (deliverables): exercises are proposed each week that each cooperative group must deliver. They are returned after a week and a solution is published with the final results and important intermediates.

Exercise control: a control carried out by a member of each group chosen at random, and its rating is assigned to all members of the group.

Individual exam (with repechage) of basic knowledge.

Material:

- Powerpoint presentations (include the statements of the activities to do in class)
- 12. Locally flat waves. Uniform flat waves (OPU)
- 13. Normal incidence flat wave dielectric
- 14. Normal incidence flat wave plane conductor
- 15. Oblique flat wave
- 16. Oblique incidence on the conductor plane
- 17. Interference and diffraction Young's experiment
- Deliverables (statements and solutions)
- 11. Normal incidence of OPU on dielectric surface
- 12. Oblique incidence of uniform plane wave in conductive plane
- Group control (statement)
- Individual exam:

Basic knowledge 5. For the problem of reflection and refraction of a plane wave on a dielectric surface in the case of perpendicular incidence, solve problems using the equivalence with transmission lines.

Basic knowledge 6. For the reflection of a wave in a conducting plane: propose and explain the analogy with transmission lines that allows its study, calculate the analytical expression of the wave reflected by the conductor with linear polarization perpendicular to the plane of incidence and analyze and discuss the total distribution of the electric field and the flow of powers.

Delivery:

Class activities: block 5

Deliverables 11 and 12

Individual exam (ordinary and repechage, if necessary): Basic knowledge 5 and 6

Related competencies :

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources. 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

Full-or-part-time: 43h Theory classes: 17h



Self study: 26h

name english

Description:

The training activities of this content are classified into two groups:

Powerpoint presentations used in class: in the theory sessions the teacher's explanations (minimum essential explanations for carrying out the exercises that the cooperative groups must do weekly as part of their autonomous learning) will alternate with activities of the students, individually or in couples.

Regular activities proposed to do in class: small activities that are collected in the same class and a control is kept of who has done them (in no case may they be done or finished outside of class hours).

Specific objectives:

- Explain the concept of complex permittivity of a lossy medium, obtain its expression for a conductive medium and make calculations of powers and attenuation for a wave in a given material medium (good conductor and good dielectric)

- Make shielding calculations based on knowledge of the waves inside conductors.

- Explain the corpuscle-wave duality and the concept of photon. Explain the concept of thermal effects of radiation and perform simple SAR calculations.

Material:

- Powerpoint presentations (include the statements of the activities to do in class)

18. Propagation of OPU in Lossy Media

Delivery: Class activities: blocks 6 and 7

Full-or-part-time: 4h Theory classes: 4h



name english

Description:

The training activities of this content are classified into two groups:

Powerpoint presentations used in class: in the theory sessions the teacher's explanations (minimum essential explanations for carrying out the exercises that the cooperative groups must do weekly as part of their autonomous learning) will alternate with student activities, individually or in couples.

Regular activities proposed to do in class: small activities that are collected in the same class and a control is kept of who has done them (in no case may they be done or finished outside of class hours).

Specific objectives:

Once this activity has been completed, the student will be able to:

- Explain how fiber optics works in multimode mode in terms of geometric optics (rays) and the concepts of numerical aperture and intermodal dispersion, calculate their expressions and solve simple practical examples.

- Explain the distinction between singlemode and multimode fiber and the concept of chromatic dispersion and solve simple practical examples.

- Explain wavelength division multiplexing and the basic architecture of an OADM (Optical Add Drop Multiplexer)

Material:

PowerPoint presentations (include the statements of the activities to do in class)

19. Fiber optics. Principles of optical communications

Delivery: Class activities: blocks 8 and 9

Full-or-part-time: 4h

Theory classes: 4h

name english

Description:

Cooperative groups have to carry out a project that will deal with electromagnetic waves (circuits with transmission lines, antennas, applications of the laws of reflection and refraction, diffraction, polarization ...).

Each group will have to solve, theoretically and experimentally, the questions that are put to it.

The groups have to carry out a previous study (a necessary condition to do the experimental part) and make an oral presentation (with powerpoint support or similar) of the measures taken and the results obtained.

If a student does not attend all the experimental sessions or the oral presentation of the project, they will be graded with a zero both in the group evaluation section and in the individual evaluation section (except in cases of force majeure, which will be analyzed and resolved case by case).

- Group evaluation

The qualification will be determined based on the previous study and the oral presentation.

Each group will have 20 minutes for the presentation and the order of intervention of the different members of the group will be decided by the teachers at the beginning of the presentation.

- Individual evaluation

As a general rule, the qualification of this section will be determined through an interview that the teachers will have with each student, the content of which will be about the different aspects worked on in the project.



If at the time of the interview, a student has passed all the basic knowledge or has a grade in the exam section equal to or greater than 5.5 points (basic knowledge criterion), it is very likely that he or she is prepared to answer on behalf of the group and In this case, you can request that the "individual evaluation" section be assigned the same rating as that corresponding to the "group evaluation" section.

Specific objectives:

After completing this activity, the student will be able to:

- Correctly use radio frequency and / or optical instruments and equipment.
- Carry out a critical analysis of the experiments and results obtained.
- Correctly interpret regulations and recommendations for the protection of health and safety against radio or optical radiation.
- Work autonomously, in a group, in a radiofrequency and / or optical laboratory.

- Carry out the assigned tasks based on the basic guidelines given by the teachers, deciding the time it is necessary to spend for each task.

- Plan the development of a well-defined project, of reduced scope, determining the distribution of responsibilities and integration.

- Use strategies to prepare and carry out an oral presentation (with powerpoint support or similar) with a coherent content, an adequate structure and style, a good spelling and grammar level and respecting the time allocated for the presentation.

Material:

PowerPoint presentations

20. Impedance matching. Smith's letter

21. Project (norms, calendar, evaluation criteria and assignment of projects)

For each project:

- Notes of the theory not explained in class necessary to do the project (self-study)
- Previous study statement
- Experimental script
- . Materials, equipment and instrumentation of the radiofrequency or optical laboratory

Delivery:

Previous study (cooperative group) Experimental performance (cooperative group) Oral presentation (cooperative group) Exam / individual interview

Related competencies :

02 GPR N2. PROJECT MANAGEMENT - Level 2: Define the objectives of a well-defined, narrow scope, and plan development, identifying resources, tasks, shared responsibilities and integration. Use appropriate tools to support project management. 01 UEQ N2. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 2: Use the correct instruments, equipment and laboratory software for specific or specialized knowledge of their benefits. A critical analysis of the experiments and results. Correctly interpret manuals and catalogs. Working independently, individually or in groups, in the laboratory.

. CE 9 TELECOM. Capacidad de analizar y especificar los parámetros fundamentales de un sistema de comunicaciones.(CIN/352/2009, BOE 20.2.2009.)

. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Full-or-part-time: 36h Laboratory classes: 4h Guided activities: 6h 30m Self study: 25h 30m



GRADING SYSTEM

The evaluation criteria defined in the infoweb of the subjects will be applied.

EXAMINATION RULES.

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Basic:

- Bará Temes, Javier. Circuits de microones amb línies de transmissió [on line]. Barcelona: Edicions UPC, 1993 [Consultation: 15/04/2020]. Available on: <u>http://hdl.handle.net/2099.3/36162</u>. ISBN 8476533381.

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Complementary:

- Hecht, Jeff. Understanding fiber optics. 4th ed. Upper Saddle River [etc.]: Prentice Hall, 2002. ISBN 0130278289.

- Pozar, David M. Microwave engineering [on line]. 2nd. ed. New York [etc.]: John Wiley & Sons, 1998 [Consultation: 26/07/2022]. A vailable on:

https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=2064 708. ISBN 0471170968.

- Iskander, Magdy F. Electromagnetic fields and waves. Englewood Cliffs, N.J.: Prentice Hall, 1992. ISBN 0132494426.

 Hecht, Eugene; Zajac, Alfred. Óptica [on line]. Argentina [etc.]: Addison-Wesley Iberoamericana, 1986 [Consultation: 26/07/2022].
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RESOURCES

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Other resources:

Material available on the ATENEA digital campus

- Subject information
- PowerPoint presentations
- Deliverable statements
- Deliverable solutions
- Mathematical and simulation software freely available: SCILAB, SMITH, VIPEC and TXLINE (manuals and links to download them).
- Projects
- Operating instructions for RF and optical instruments