Electromagnetic Compatibility

Code: 102725
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500895 Electronic Engineering for Telecommunication	OT	4

Contact

Name: Enrique Alberto Miranda Castellano

Email: enrique.miranda@uab.cat

Teachers

Enrique Alberto Miranda Castellano

Teaching groups languages

You can view this information at the end of this document.

Prerequisites

- Vectorial analysis (vectors, scalar and vector fields, differential operators: gradient, rotor, divergency, laplacian)
- Fundamentals of electromagnetism (Coulomb's law, Ampere's law, Gauss Theorem, propagation of electromagnetic waves in transmission lines and in vacuum)
- Fundamentals of circuit analysis

Objectives and Contextualisation

The objective of this course is to form students from the Telecomunications degree in the models and methods frequently used in the field of electromagnetic compatibility (EMC). To this aim, the basic formulations used for the description of interference phenomena and electromagnetic compatibility will be presented. We will also study the national and international directives currently active. We will explore the interference sources and how they are measured using professional instruments.

Competences

- Apply the necessary legislation in the exercise of the telecommunications engineer's profession and use the compulsory specifications, regulations and standards
- Communication

- Conceive, design, implement and operate electronic instrumentation and control equipment and systems.
- Develop ethics and professionalism.
- Develop personal attitude.
- Develop personal work habits.
- Develop thinking habits.
- Learn new methods and technologies, building on basic technological knowledge, to be able to adapt to new situations.
- Manage activities involved in projects in the field of telecommunications.
- Work in a multidisciplinary group and in a multilingual environment, and communicate, both in writing and orally, knowledge, procedures, results and ideas related with telecommunications and electronics
- Work in a team.

Learning Outcomes

1. Analyse and specify the fundamental parameters of a communications system, in terms of instrumentation.
2. Analyse and troubleshoot electromagnetic interference and compatibility.
3. Autonomously apply new knowledge and proper techniques for the design, development or operation of electronic systems.
4. Communicate efficiently, orally and in writing, knowledge, results and skills, both professionally and to non-expert audiences.
5. Develop critical thinking and reasoning.
6. Develop curiosity and creativity.
7. Develop independent learning strategies.
8. Develop the capacity for analysis and synthesis.
9. Document the instrumentation systems designed, based on current standards.
10. Evaluate the advantages and disadvantages of different technological alternatives for the deployment or implementation of electronic systems, in terms of disturbance and noise.
11. Identify the standards and regulations for telecommunications in the national, European and international areas in the field of electromagnetic compatibility
12. Perform the specification, implementation, documentation and fine-tuning of electronic instrumentation and control equipment and systems , considering technical aspects and the relevant regulatory requirements.
13. Prevent and solve problems.
14. Respect diversity in ideas, people and situations.
15. Work autonomously.
16. Work cooperatively.

Content

Content of the course:

1.- Introducción a la EMC

Motivación. Ejemplos introductorios. Definiciones y terminología

Modelo fuente-acoplo-víctima

Fuentes de interferencia naturales y artificiales

Mecanismos de acoplamiento: interferencia conducida y radiada

Conceptos de inmunidad y susceptibilidad

Espectros de señales. Análisis de señales pulsadas

Dimensión eléctrica

Unidades comúnmente utilizadas en EMC. Decibelio

2.- Principios electromagnéticos básicos

Análisis vectorial. Sistemas de coordenadas

Campos estáticos. Potenciales escalares y vectoriales

Líneas de alta tensión. Bobinas de Helmholtz

Materiales dieléctricos y magnéticos. Cargas y corrientes equivalentes

Ecuaciones de Maxwell. Propagación de ondas electromagnéticas

Entornos de modelización en EMC

3.- Modelos de baja frecuencia

Resolución de las ecuaciones de Laplace y Poisson

Método de elementos finitos y diferencias finitas

Circuitos de parámetros concentrados

Modelos de acoplamiento circuital: acoplamiento por conducción e inducción.

Diafonía en circuitos impresos (crosstalk)

Descarga electrostática (ESD). Modelización y técnicas de prevención

4.- Modelos de alta frecuencia

Ecuaciones delas líneas de transmisión con y sin pérdidas

Interacción de campos electromagnéticos con líneas de transmisión

Lineas de transmisión multiconductoras

Ecuación de Baum-Liu-Tesche

Método de diferencias finitas en el dominio del tiempo

Efectos de la caída de un rayo sobre una línea

Campos de radiación y de inducción

Radiación de fuentes extensas y aberturas

Método de momentos. Acoplamiento de fuentes extensas

4.- Apantallamiento

Topología electromagnética en EMC

Atenuación de la interferencia conducida

Efectividad del blindaje. Blindaje en circuitos integrados

Blindaje eléctrico a baja y alta frecuencia

Blindaje magnético a baja y alta frecuencia

Filtros de ferrita y filtros pasantes

Sistemas absorbentes

Diseño de recientos con aberturas

5.- Mediciones y Control

Desarrollo de sistemas bajo criterios de EMC

Sistemas de preconformidad

Métodos y equipos para la medición de interferencias

Receptores y LISN. Factor de antena

Ambientes de medición. Planos de reverberación

Cámaras anecoicas y celdas TEM

6.- Normativas y aplicaciones

Organismos reguladores

Estándares y normativa internacional sobre EMC

Declaración de conformidad. Cadena de responsabilidades

Electrodomésticos

Equipos de tecnología de la información

Arquitectura

Transportes

Equipamiento médico

Aspectos vinculados a la iluminación

7.- Aspectos biológicos de los campos electromagnéticos

Sociedad y campos electromagnéticos

Espectro electromagnético

Radiación ionizante y no ionizante

Baja frecuencia

RF y microondas

Efectos térmicos y lipoatrofia

Normativa y limites de exposición

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Directed	15	0.6	2, 6, 12, 16
Directed	30	1.2	1, 2, 5, 9, 10, 11, 14
Type: Supervised			
Supervised	10	0.4	7, 13
Type: Autonomous			
Autonomous	20	0.8	3, 5, 8, 11, 13
Autonomous	20	0.8	1, 7, 8, 11

Along the course, the students will have to present activities (analysis of papers, readings, etc) assigned by the professor related to the Unity under study. The students will carry out some simulation practices about the subject discussed in the theory classes. The students must also present one subjected related to EMC in agreement with the professor's directives. The course ends with an individual evaluation about the contents of the course.

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
Activity 1	see below	40	1.6	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16
Activity 2	see below	10	0.4	5, 7, 8, 12, 15
Activity 3	see below	5	0.2	4, 6, 7, 14, 16

Activities:

- 4 practices (0.56) i 1 oral presentation (0.14) (70% weight)
- 1 individual evaluation (30% weight)

The minimum score in the individual evaluation is 5/10.

A minimum of 5 points is required to approve the course.

Bibliography

Bibliography

C. R. Paul, Introduction to electromagnetic compatibility. Second Edition, John Wiley & Sons, 2006

C. Christopoulos, Principles and techniques of electromagnetic compatibility, CRC Press, 1995.

J. Sebastian, Fundamentos de compatibilidad electromagnética, Addison-Wesley 1999.

C. R. Paul, Analysis of multiconductor transmission lines, IEEE Press, 2008.

Addicional

F.M.Tesche, M.V.Ianoz and T. Karlsson, EMC Analysis Methods and Computational Models, Wiley, 1997.

N. Ellis, Interferencias Eléctricas Handbook, Paraninfo, 1999.

T. Williams, EMC Control y limitación de energía electromagnética, Paraninfo, 1997.

D. Weston, Electromagnetic Compatibility, Principles and Applications, Dekker, 2001.

R. Leventhal, Semiconductor modeling for simulating signal, power and electromagnetic integrity, Springer, 2006.

Software

The simulation software is provided by the professor

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	321	Catalan/Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	321	Catalan/Spanish	second semester	morning-mixed
(TE) Theory	320	Catalan/Spanish	second semester	morning-mixed