COURSE DATA

Data Subject	
Code	34893
Name	Data transmission
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1403 - Degree in Telematics Engineering	School of Engineering	3	Second term

Subject-matter

Degree	Subject-matter	Character
1403 - Degree in Telematics Engineering	14 - Digital communications	Obligatory

Coordination

Name	Department
SEGURA GARCIA, JAUME	240 - Computer Science

SUMMARY

This subject is part of the art "Digital Communications", being preceded by the subjects "Mathematical Foundations of Communications" and "Theory of Communication", and delivered simultaneously to the subject of "Digital Signal Processing," also belonging to the same subject. In the course you are 6 credits and is taught in the 2nd semester of 3rd year, coinciding with the corresponding subject of additional training courses.

It is assumed that the student is familiar with the tools necessary mathematics (linear algebra, probability and stochastic processes, optimization, and linear signals) and the basics of communications. This course represents a natural continuation of the subject "Communication Theory,"which covers the basics of digital modulation, coding of source and channel base as well as optimal detection and decoding in single channels, taking into account the fundamental limits set by information theory. The subject "Data Transmission"delves into the techniques of modulation, coding and design of digital communications receivers used in current communications systems. These techniques make up the so-called physical layer (inside layer model for communication), whose objective is the reliable transmission of bits from one extreme to another in modern digital communication today. It covers the transmission and reception schemes for linear channels covering optimal detection techniques, efficient techniques of linear

equalization in receivers, advanced channel codes and multipulse modulation. It analyzes and evaluates the performance of different techniques based on basic parameters such as bandwidth, the SNR and the probability of error, also analyzing the inherent limitations of the different algorithms and their use in practice in different communication standards (WLAN, UMTS, DVB, ADSL, Bluetooth, LTE, etc ...).

The general objectives for this course are:

1. Theoretical Foundations of coding techniques, modulation, demodulation and detection, used in linear channels as well as fundamental limits on benefits that exist.

2. Linear equalization algorithms in receivers for channels with intersymbol interference (ISI), analyzing the inherent limitations of these algorithms.

3. Representation and design of convolutional encoders and decoders, analyzing their practical performance.

4. Transmission and reception structures based on multipulse modulation, multicarrier modulations mainly multicarrier modulation (OFDM) and spread spectrum modulation.

5. Implementation of different algorithms and their practical use in the various associated standards that are currently used in communications systems.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

You must meet one of the following two conditions: a) having previously completed this degree in the subject of mathematics and the subject of Signals and Linear Systems and Fundamentals of Telecommunication Systems (of matter Signals, Systems and Telecommunication Services) , the subjects of mathematical Foundations of Communication and Communication Theory for the same subject (Digital Communications), b) having completed Telematics Engineering of the current plan until now.

OUTCOMES

1403 - Degree in Telematics Engineering

- R4 - Ability to analyze and specify the fundamental parameters of communication systems.

- R5 - Ability to assess the advantages and drawbacks of different technological alternatives for the deployment and implementation of communications systems, from the point of view of signal space, perturbations and noise and analogue and digital modulation systems.
- R1 - Ability for self-learning of new knowledge and techniques appropriate for the conception, development and exploitation of telecommunications systems and services.
- G4 - Ability to solve problems with initiative, decision-making and creativity, and to communicate and transmit knowledge, abilities and skills, understanding the ethical and professional responsibility of the activity of a telecommunications technical engineer.
- G5 - Knowledge to carry out measurements, calculations, assessments, evaluations, loss adjustments, studies, reports, task planning, and other analogous work in the specific field of telecommunications.
- G6 - Ability in the handling of specifications, regulations and norms of compulsory compliance.
- R8 - Ability to understand the mechanisms of propagation and transmission of electromagnetic and acoustic waves, and their corresponding transmitting and receiving devices.
- G1 - Ability to write, develop and sign projects in the field of Telecommunication Engineering aimed - according to the knowledge acquired in section 5 of CIN/352/2009 regulation - at the conception and the development or the exploitation of networks, services and applications of telecommunications and electronics.
- E1 - Ability to construct, exploit and manage telecommunication networks, services , processes and applications, understood as systems for the acquisition, transport, representation, processing, storage, management and presentation of multimedia information, from the perspective of telematics services.
- E5 - Ability to follow the technological progress of transmission, commutation and proccess to improve the telemactic networks and services.

LEARNING OUTCOMES

The key outcomes to be achieved as a result of learning this matter are essentially practical, and are measured by the degree to which the student has acquired the following skills:

1. Being able to choose from among the techniques discussed in the course, which one may be appropriate for the resolution of a particular communications problem, and how to apply. (R1,R4,R5, G4)

2. Knowing how to analyze the performance of different algorithms used (coding, modulation, demodulation, decoding), its limitations compared to existing fundamental limits. (R1, R4, R5)

3. Knowing how to design efficient algorithms for matching different receivers for channels with intersymbol interference (ISI), analyzing the inherent limitations of these algorithms. (R1, R4, R5)

4. Knowing how to design convolutional encoders and decoders, analyzing their practical performance. (R4, R5, E1)

5. Understanding and being able to design the transmitter and receiver structures based on multipulse modulation, multicarrier modulations mainly (OFDM) and spread spectrum modulation. (R4, R5, G6)

6. Knowing how to implement different algorithms and show its use in the various standards that exist in current communication systems.

7. Being able to assess the quality of the solution by calculating the appropriate efficiency measures, and if the solution is not satisfactory, to correct it. In an extreme case (the system is extremely complex or highly variable) should be able to explain why the solution does not work properly and look for alternatives in the literature. (R1, R4, R5)

To this end, the evaluation will be based on the resolution of problems not requiring mechanical and important domain of concepts and methods, both in the exercises on a regular basis as in the tests or any proposed major works.

In addition to the specific objectives mentioned above, the course will encourage the development of several more generic skills, among which include:

- The ability to identify existing technological systems, as well as the breakdown in the various subsystems that comprise it.

- Promotion of teamwork and organizational tasks and subtasks.

DESCRIPTION OF CONTENTS

1. Digital Modulation and Detection in gaussian channels

Transmission and reception schemes, matched filter and optimum detection, review of modulations in amplitude, phase and frequency, transmission in pass-band, equivalent representation in complex base-band, equivalent discrete channel, computation of symbol and bit error probabilities.

	Presence	No Presence
Theory	9	14
Problems	4	7

2. Detection in channels with inter-symbol interference

Design of ISI-free pulses (Nyquist criterion), amplitude modulation transmission over linear channels, the problem of inter-symbol interference, equivalent discrete channel, maximum likelihood detection of sequences in the presence of ISI, linear equalization, adaptive equalization, performance and error probabilities.

	Presence	No Presence
Theory	6	8
Problems	2	5

3. Convolutional Channel codes

Motivation of the need of channel codes, convolutional channel codes, representation of linear convolutional codes, classes of convolutional encoders, Viterbi decoding algorithm, performance analysis of convolutional codes, associated standards.

Presence No Presence
Theory 10 15
Problems 3 5

4. Multi-pulse modulations

Multi-carrier modulation (OFDM) in continuous-time and discrete-time, receivers for multi-carrier modulations, elimination of ISI and ICI, transmission and reception of spread spectrum modulation ,RAKE receivers, design of sequences for spread spectrum, benefits and error probabilities, associated standards.

Presence No Presence
Theory 9 13
Problems 2 4

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Development of individual work	15,00	0
Study and independent work	15,00	0
Readings supplementary material	15,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The training activities are conducted in accordance with the following distribution:

40% of the hours of ECTS credits (1 credit is 25 hours) will go to the following sessions:

1 / Class work consists of:

1.1 / theory classes, which consist of the presentation and basic explanation of the matter concerned. Periodically propose short-term activities, which require the involvement of students in order to confirm the understanding of the theory exposed. (R4,R5, G4)

1.2 / exercise classes, designed to solve larger problems or conceptual, or temporary. (R1,R4,R5, G4)

1.3 / laboratory classes designed to test experimentally some of the most important views in theory classes. (R1,R4,R5, G4)

60% of the hours of ECTS (25 hours per ECTS) will be devoted to the following non-contact activities:

2 / class work consists of:

2.1 / resolution and presentation exercises. It is about solving problem sets proposed by the teacher and / or public display of the resolution of some of them. (R1,R4,R5, G4)

2.2 / preparation and testing. (R1,R4,R5, G4)

2.3 / preparation of laboratory practice, for which the student must have read and digested the contents of the newsletter of practice and have reviewed the relevant theory. (R1,R4,R5, G4).

EVALUATION

The assessment consists of teachers selected the following items and ratings:

Results of the midterm exam (30% of final mark)

Assistance and implementation of practices (20% of final grade)

Assistance and resolution proposed exercises (20% of final mark)

Final exam (30% of final grade)

In case that it is decided not to have a midterm exam, the percentage of the final exam will be 60%.

For students who cannot attend class regularly, offers an alternative model in which the value of attendance and participation will be replaced by some extra work and special tutoring assistance, with a total percentage equivalent.

In this subject it is necessary to obtain some minimums to be able to do average with all the notes of the subject. These minimums will be the equivalent of a 3.5 out of 10 in both the partial and / or final exam. The other evaluable items are not subject to a minimum. The pass of the subject will be obtained with a weighted average of 5 among all the evaluable items.

Be considered a student attends class regularly when there is missed more than 25% of tuition given up half the time of delivery of the course, when you come to that time.

In any case, the system of evaluation will be ruled by the established in the Regulation of Evaluation and Qualification of the University of Valencia for Degrees and Masters. (http://www.uv.es/graus/normatives/2017_108_Reglament_avaluacio_qualificacio.pdf).

REFERENCES

Basic

- Referencia b1: Trasparencias de la asignatura en Aula Virtual
- Referencia b2: Madhow. U., Fundamentals of Digital Communication, Cambridge, 2008, ISBN: 978-0-521-87414-4
- Referencia b3: Artés Rodríguez, A., Pérez González, F., Comunicaciones Digitales, Prentice Hall,2007, ISBN: 978-84-8322-348-2

Additional

- Referencia c1: Moon T. K., Error Correction Coding, Wiley-Interscience, 2005, ISBN: 978-0471648000
- Referencia c2: Lin, S., Costello, D. J., Error Control Coding (second edition), Prentice Hall, 2004, ISBN: 978-0130426727
- Referencia c3: Blahut R. E., Algebraic codes for Data Transmission, Cambridge 2006, ISBN: 0-521-55374-1

- Referencia c4: J. G. Proakis, M. Salehi, G. Bauch, Contemporary communication systems using MATLAB and Simulink, Thomson, 2004, ISBN: 471648000
- Referencia c5: Driscoll T.A., Learning MATLAB, 2009, ISBN: 978-0898716832
- Referencia c6: Sigmon K., MATLAB Primer, Third Edition, 1993 (available online)
- Referencia c7: Getting Started with MATLAB, ©The MathWorks (available online)