VNIVERSITAT DE VALÈNCIA

Course Guide
34890 Mathematical bases of communications

COURSE DATA

Data Subject	
Code	34890
Name	Mathematical bases of communications
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1403 - Degree in Telematics Engineering	School of Engineering	2	Second term

Subject-matter

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

Coordination

Name	Department
ROGER VAREA, SANDRA	240 - Computer Science

SUMMARY

The course “Fundamentos Matemáticos de las Comunicaciones” takes place in the second course, second term of the “Grado en Ingeniería Telemática”. This course is part of the common core “Comunicaciones Digitales” and it states the basics of a set of courses that are taught in the third course, such as “Teoría de la Comunicación”, “Procesado Digital de la Señal” and “Transmisión de Datos”. The course “Fundamentos Matemáticos de las Comunicaciones” can also be seen as a complement of the previous course “Señales y Sistemas Lineales”, where the main assumption is that the signals or inputs to the systems are deterministic. In practical systems, these inputs are mainly stochastic processes. One example are noisy signals, appearing in several communication systems.

The course introduces the basic concepts of probability theory, random variables and stochastic processes, which are used in many communication systems when dealing with the mathematical modelling of the different blocks. In a later step, the fundamentals of detection theory are reviewed.

The aim of this course is to provide the students with the knowledge and ability to tackle the remaining courses of the core “Comunicaciones Digitales”. Key aspects of the course are the identification and proper use of the probability, statistics and random processes concepts as a tool for the modelling, analysis, transmission and reception of signals over the different communication 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

Matemáticas I, II y III
Señales y Sistemas Lineales

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1403 - Degree in Telematics Engineering

- R4 - Ability to analyze and specify the fundamental parameters of communication 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.
- G6 - Ability in the handling of specifications, regulations and norms of compulsory compliance.
- 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 (RD 1393/2007) // NO CONTENT (RD 822/2021)

This course provides the following fundamental skills:

- Capacity to learn in an autonomous way new concepts and techniques suitable for the design, development and exploitation of systems and telecommunication services.(R-1)

- Capacity to follow the process of transmission, and the process to improve the networks and telematics services.(E-1,E-5, G-6)

The course also provides the following complementary social skills:

- Calculation of probabilities and moments.(R-4)

- Identify everyday situations in communication systems and networks where certain probability distribution functions can be applied. (R-4,E-5)

- Use of random variables to model processes and perform estimations in telecommunication systems. (R-1,R-4,G-4)

- Understand the fundamentals of stochastic processes and apply them in telecommunication processes, with focus on telematics. (R-1,R-4,G-4)

- Understand the fundamentals of detection theory. (R-1,R-4,G-4)

- Promote team work and the task splitting ability.(R-1)

DESCRIPTION OF CONTENTS

1. The axioms of probability

Probability models, the axioms of probability, discrete and continuous sample spaces. Independence of events and conditional probability. Bayes rule.

2. One random variable

Discrete and continuous random variables. The cumulative distribution and probability density functions. Functions of a random variable. Transform methods. Parameter estimation: mean and variance of a random variable. Important discrete and continuous random variables. Moments.

3. Vector random variables

Joint cumulative distribution and probability density functions. Conditional probability. Functions of two random variables. The n-dimensional Gaussian distribution. Expectation and moments. Transformation of random vectors. Sums of random variables. Sample mean and variance. Correlation and covariance. Orthogonality, independence and incorrelation.

4. Basics of detection theory

Hypothesis testing, error probability, sufficient statistic.

5. Introduction to random processes

Definition and examples. First and second moments of a random process. Properties: Independence, stationarity and ergodicity. Power spectral density.

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	10,00	0
Study and independent work	20,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	15,00	0
Resolution of case studies	15,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

1) Work at the course:

a) Theory sessions, including short activities for the students (R-4, R-1, E-5).

b) Problem solving sessions, to practice the concepts from the theory sessions (R-4, G-4, G-6, E-1).

c) Lab sessions, understanding by means of simulations the most important concepts from the theory sessions (R-4, G-4, G-6, E-1, R-1).

2) Student’s own work:

a) Homework and exposition in class of the solution (R-4, G-4, E-1, R-1).

b) Exam preparation (R-4, R-1, E-1, E-5).

c) Lab sessions preparation, reading the lab description and the related theoretical concepts (R-4, R-1, E-1, E-5).

3) Consulting sessions:

A certain number of hours are established each week, which the students can attend in order to solve doubts (R-1).

EVALUATION

The course evaluation follows a modified conventional approach, not reaching a full continuous-time evaluation. The following items are considered for the first call:- Attendance to the course lessons (5% of the final mark)- Positive disposition when attending the course lessons (5% of the final mark) (R-4, R-1, E-5).- Lab sessions (20% of the final mark) (R-4, G-4, G-6, E-1, R-1). Lab attendance is a compulsory and non-recoverable item to pass the subject in the first evaluation. The student can only miss one of the sessions unjustified.- Homework (15% of the final mark) (R-4, G-4, E-1, R-1).- Exam (55% of the final mark) (R-4, R-1, E-1, E-5).
For the students who cannot attend the course lessons, an alternative evaluation is proposed, where the attendance is replaced by solving additional homework.
In the second call, students will have to choose between two evaluation options, to be chosen and indicated to the profesor before the date of the final exam:A) Same percentages as in the first call, only repeating the final exam.B) Exam (80% of the final mark) + Lab sessions (20% of the final mark, non-recoverable)
The minimum mark required to pass the course is 3.5 over 10 in the final exam. The remaining items are not subject to a minimum.
In any case, the evaluation system will correspond to the one established in the Regulation for Evaluation and Qualification of the Universitat de València for Degrees and Masters (https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639)

REFERENCES

Basic

- Therrien, Charles W., Tummala, Murali, Probability for Electrical and Computer Engineers, CRC Press, 2nd edition, 2012, ISBN: 978-1-4398-2698-0

Additional

- Gubner, John A., Probability and Random Processes for Electrical and Computer Engineers, Cambridge, 2006, ISBN: 0521864704 (recurso electrónico, acceso limitado a la UV).
- Stark, Henry, Woods, John W., Probability and Random Processes with Applications to Signal Processing, Third Edition, Prentice Hall, 2002, ISBN: 0131784579.
- Ross, Sheldon M., Introduction to Probability and Statistics for Engineers and Scientists, Third Edition, John Wiley & Sons, 2004, ISBN: 0125980574.
- Leon-Garcia, Alberto, Probability, Statistics, and Random Processes for Electrical Engineering, Third Edition, Pearson Education, 2009, ISBN: 9780137155606.
- Yates, Roy D., Goodman, David J., Probability and stochastic processes: a friendly introduction for electrical and computer engineers, 2nd edition, John Wiley & Sons, 2005, ISBN: 978-0-471-27214-4.

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

The contents initially included in the teaching guide are maintained.

Workload and temporary teaching planning

The different activities described in the teaching guide are maintained with the planned dedication.

The material for the follow-up of the classes of theory/practices allows to continue with the professor of temporary planning so much in days as in schedule, so much if the teaching is face-to-face in the classroom or if it is not.

Teaching methodology

In classroom theory and practices, students will tend to have the maximum physical attendance possible, always respecting the sanitary restrictions that limit the capacity of the classrooms as indicated by the competent public health authorities to the estimated percentage of their usual occupation.

Depending on the capacity of the classroom and the number of students enrolled, it may be necessary to distribute the students into two groups. If this situation arises, each group will attend classroom theory and practical sessions with physical presence in the classroom by rotating shifts, thus ensuring compliance with the criteria for occupying spaces.

The rotation system will be established once the actual enrollment data is known, guaranteeing, in any case, that the attendance percentage of all the students enrolled in the subject is the same.

With respect to laboratory practices, attendance at sessions scheduled in the schedule will be totally face-to-face.

Once the actual enrollment data is available and the availability of spaces is known, the Academic Committee of the Degree will approve the Teaching Model of the Degree and its adaptation to each subject, establishing in said model the specific conditions in which it will be developed teaching the subject.

If there is a closure of the facilities for sanitary reasons that totally or partially affects the classes of the subject, these will be replaced by non-contact sessions following the established schedules.

Evaluation

The evaluation system described in the teaching guide of the subject in which the different evaluable activities have been specified as well as their contribution to the final grade of the subject is maintained.

If there is a closure of the facilities for health reasons that affect the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the Universitat de València.

The contribution of each evaluable activity to the final grade for the course will remain unchanged, as established in this guide.

Bibliography

The bibliography recommended in the teaching guide.