Universitat Autònoma de Barcelona

2021/2022

Foundations of Communications

Code: 102714
ECTS Credits: 10.5

Degree	Type	Year	Semester
2500895 Electronic Engineering for Telecommunication	OB	2	2
2500898 Telecommunication Systems Engineering	OB	2	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Jose Lopez Vicario
Guillem Boquet Pujadas

Prerequisites

The student must have an adequate level of calculation (functions of real and complex variable, complex numbers, differentiation and integration), statistics (basic concepts of stochastic processes) and signals and systems (properties of systems, convolution equation, transformed Fourier, frequency response, correlation and spectrum of deterministic signals).

Objectives and Contextualisation

- Know and know how to apply the concepts of correlation and spectrum of random signals.
- Identify the main blocks of a communications system and its features.
- Know the linear, phase and frequency analogue modulations.
- Know how to calculate the signal to noise ratio in analogue communication systems.
- Introduce the student in the concepts of sampling, quantification and source coding.
- Understand digital modulations.
- Know how to represent the signals with digital modulations in vector form and obtain the probability of error.
- Understand intersymolic interference and know how to apply equalization systems.

Competences

Electronic Engineering for Telecommunication

- Communication

- 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.
- Resolve problems with initiative and creativity. Make decisions. Communicate and transmit knowledge, skills and abilities, in awareness of the ethical and professional responsibilities involved in a telecommunications engineers work.
- 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.

Telecommunication Systems Engineering

- Communication
- 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.
- Resolve problems with initiative and creativity. Make decisions. Communicate and transmit knowledge, skills and abilities, in awareness of the ethical and professional responsibilities involved in a telecommunications engineers work.
- 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 design analogue and digital communication diagrams.
2. Analyse and design digital signal processing diagrams.
3. Analyse and specify the fundamental parameters of a communication system.
4. Analyse and specify the fundamental parameters of a communications system.
5. Assume and respect the role of the different members of a team, as well as the different levels of dependency in the team.
6. Communicate efficiently, orally and in writing, knowledge, results and skills, both professionally and to non-expert audiences.
7. Develop curiosity and creativity.
8. Develop independent learning strategies.
9. Develop systemic thinking.
10. Develop the capacity for analysis and synthesis.
11. Efficiently use ICT for the communication and transmission of ideas and results.
12. Evaluate the advantages and disadvantages of different conceptual and technological options for different telecommunication applications.
13. Evaluate the advantages and disadvantages of different technological alternatives for the deployment or implementation of communication systems, in terms of signal space, disturbance and noise and the analogue and digital modulation systems.
14. Identify, manage and resolve conflicts.
15. Illustrate signal and communication processing algorithms using a basic mathematical formalism.
16. Illustrate the algorithms of signal processing and communications using a basic mathematical formalism.
17. Make ones own decisions.
18. Statistically characterise noise and analyse its effect on analogue and digital modulations.
19. Statistically characterize noise and analyse its effect on analogue and digital modulations.
20. Use computer tools to research bibliographic resources and information on telecommunications.
21. Use computerised search tools to find bibliographic resources or information related to telecommunications.
22. Work autonomously.
23. Work cooperatively.

Content

1. Random signals
    1. Need to work with random signals
    2. Random variables (review)
    3. Random processes
    4. Autocorrelation
    5. Spectral density in stationary random processes
    6. Noise
3. Analog Baseband Transmission
    1. Elements of a communications system in base band
    2. Linear distrosion
    3. Nonlinear distortion
    4. Loss of transmission
    5. Filters
    6. Signal-to-noise ratio (SNR)
5. Analog Pass-band Transmission
    1. Elements of a pass-band communications system
    2. Step-band signals: analytical signal and step-down equivalent
    3. Filtering equivalent step-by-step
    4. Modulation and demodulation of step-by-step signals
    5. Autocorrelation and spectral density of non-band signals
    6. Phase delay and group delay
    7. Noise bandwidth
    8. Application cases: AM and DBL. Calculation of SNR
    9. Laboratory case: FM
7. Digital Baseband Transmission
    1. Introduction
    2. Signaling
    3. Spectral density of the digital PAM signal
    4. Noise and errors in digital transmission: probability of error
    5. Adaptive filter
    6. Intersimbolic interference and Nyquist pulses
    7. Discrete equalization
9. Digital Pass-band Transmission
    1. Introduction
    2. Basic digital modulations
    3. The signal space
    4. Optimal receiver filter
    5. Probability of error
11. Coding of analog signals
    1. Sampling
    2. Quantization
    3. PCM and differential PCM

Methodology

The subject will consist of a part of theory, a part of problems and a third part of laboratory practices. In the theory part, master classes will be held. This part requires a strong dedication of the student in the form of individual work in order to consolidate and complete the contents exposed in class. That is why it will be available to you the notes of the subject done by the teaching staff, which cover the entire syllabus, the recommended bibliography and the tools of the TIC.

The second part of the subject will focus on the resolution of practical problems. There will be a part of the problems that the teacher will solve in class and another part that the student will have to solve in the form of individual work.

The third part of the subject will consist of four practical sessions in the laboratory that will serve both to contrast theoretical knowledge acquired and also to learn new concepts from a practical point of view.

The communication tool of the teaching staff with the students will be the Virtual Campus of the UAB: https://cv.uab.cat.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory sessions	12	0.48	1, 4, 5, 13, 19, 6, 8, 10, 7, 16, 15, 17, 23, 22
Master classes	38	1.52	1, 4, 13, 19, 10, 7, 16, 15
Problems Sessions	15	0.6	1, 4, 13, 19, 10, 7, 16, 15
Synthesis sessions	18	0.72	1, 4, 13, 19, 10, 7, 16, 15
Type: Supervised			
Tutorships	14	0.56	1, 4, 5, 13, 19, 6, 10, 7, 11, 16, 15, 17, 23, 22, 21, 20
Type: Autonomous			
Individual work of the student	135.5	5.42	1, 4, 13, 19, 6, 9, 8, 10, 7, 11, 16, 15, 17, 23, 22, 21, 20

Assessment

The subject is divided into theory (80%) and practices (20%). The final grade (NF) of the subject is calculated based on the theory note (NT) and the practice mark (NP) according to:

- NF = 0.8 * NT + 0.2 * NP and NT> = 4.0
- NF = min (0.8 * NT + 0.2 * NP; 4.0) and NT <4.0

Obtaining the theory note (NT):

- Through a process of continuous evaluation: it consists of 4 test-type tests throughout the course with a weight of 25% on theory (20% on the final qualification) and an approximate duration of 1.5 hours. They are distributed according to: 1 test of topics 1-2 (P1), 1 test of topic 3 (P2), 1 test of topic 4 (P3) and 1 test of topic 5 (P4).
- Recovery process: final test (PR) exam with a weight of 100% on theory (80% on the final grade). All the contents of the course are entered and it lasts approximately 3 hours.
- Improvement of NP qualification in PR exam: allowed but it is always the PR grade which will be considered, not the maximum between PR and the continuous evaluation grade. However, it is allowed to view the exam and, if so considered, do not hand in.

Obtaining the laboratory note (NP):

- Assistance and participation in the laboratory (ALAB): it represents 30% of the practice mark NP (6% of the final grade). This activity is not recoverable.

- Laboratory Tests (PLAB): At the end of each session, a test of approximately 1/2 hour duration will be enabled in which the work done in the laboratory session will be evaluated. The average of the marks of the four tests is calculated and this supposes 70% of the mark of practices NP (14% on the final qualification).
- Laboratory Recovery (PRLAB): 1 hour written test to recover PLAB.
- Use the recovery to improve the PLAB note: it is allowed, but unlike the recovery of the theory part, in case the student submits to the test is obliged to deliver and the PRLAB note will be valid both PRLAB > = PLAB as if PRLAB <PLAB.

Scheduling of evaluation activities:

- The calendar of the evaluation activities will be given on the first day of the subject and will be made public through the Virtual Campus and on the website of the School of Engineering, in the exams section.
- The final exam lasts a total of approximately 4.5 hours with the following timing: PR (approx. 3 hours) - Rest (approx. 0.5 hours) - PRLAB (approx. 1 hour). However, the PRLAB could be scheduled for a different day (notifying via Virtual Campus at the beginning of the course).

Evaluation of repeating students:

- No differences in the theory section.
- Laboratory:

  The grade obtained in previous courses can be validated as long as NP> = 5.0.
  f a student with the possibility of validating internships re-enrolls in internships and is therefore assessed on ALAB, PLAB, PRLAB (any combination), he is considered to have chosen to be re-evaluated. Therefore, in no case will the grade obtained in previous calls be taken into account.

Recovery process:

- The student can take the PR or PRLAB tests as long as he / she has taken a set of activities that represent at least two thirds of the total grade of the subject.
- In the event that a student is unable to attend the P1, P2, P3, P4 or PLAB tests for justified reasons, he / she must present the corresponding written, signed and sealed receipt. In this case it will be possible to be evaluated of the test in question with a qualification of 0,0 not thus preventing the participation in the recovery process.
- Under no circumstances will additional assessment tests be conducted if a student is unable to attend any of the tests, except in fully justified situations that do not allow attendance at the test, such as attending a court summons or being hospitalized.

Qualifications review procedure:

- For each assessment activity, a place, date and time of review will be indicated in which the student will be able to review the activity with the teacher. In this context, claims may be made on the grade of the activity, which will be evaluated by the teachers responsible for the subject. If the student does not appear in this review, this activity will not be reviewed later.
- In the event that a student is unable to attend a review, he / she may request the teacher responsible for the subject to review his / her test after the review with the other students. To do this, it is necessary: i) that the student make the application before the date and time of the start of the review and ii) present written, signed and sealed proof, with the reasons why he cannot attend.

Qualifications:

- Honors(MH): granting an honorific registration is a decision of the teaching staff responsible for the subject. The regulations of the UAB indicate that MH can only be awarded to students who have obtained a final grade of 9.00 or more. It can be granted up to 5% of MH of the total number of students enrolled.
- Astudent will be considered non-evaluable (NA) if one of the following situations occurs:

  You do not get a minimum grade of 0.5 in (P1 + P2 + P3 + P4) / 4.
  You do not get a minimum grade of 0.5 to PR.

It has not been presented to a set of activities that represent at least two thirds of the total grade of the subject.

Irregularities by the student, copy and plagiarism:

- Without prejudice to other disciplinary measures that may be considered appropriate,the irregularities committed by the student will be qualified with a zero that can lead to a variation in the rating of an evaluation act. Therefore, copying, plagiarism, deception, letting go, etc. in any of the evaluation activities it will imply to suspend with a zero. Evaluation activities qualified in this way and by this procedure will not be recoverable.
- It should be noted that tests P1, P2, P3 and P4 are recovered jointly in the PR test, and therefore plagiarism in one of them does not allow the student to be assessed for PR. The same happens with the practice tests (PLAB) and the corresponding recovery (PRLAB).

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Attendance and participation at laboratory (ALAB)	6%	12	0.48	1, 2, 4, 3, 5, 13, 12, 19, 18, 6, 10, 7, 15, 23
Laboratory recovery exam (PRLAB)	14%	1	0.04	1, 2, 4, 3, 5, 13, 19, 18, 6, 9, 8, 10, 7, 11, 14, 16, 15, 17, 23, 22, 21, 20
Partial exam topic 3 (P2)	20%	1.5	0.06	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial exam topic 4 (P3)	20%	1.5	0.06	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial exam topics 1 and 2 (P1)	20%	1.5	0.06	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial exam topics 5 and 6 (P4)	20%	1.5	0.06	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17
Recovery (PR)	80%	3	0.12	1, 4, 3, 13, 12, 19, 18, 10, 17
Tests of laboratory (PLAB)	14%	8	0.32	1, 2, 4, 3, 5, 13, 12, 19, 18, 6, 9, 8, 10, 7, 11, 14, 16, 15, 17, 23, 22, 21, 20

Bibliography

1. J.G. PROAKIS, M.SALEHI, Communication Systems Engineering, Prentice Hall, 2001 (2nd edition).
2. A. B. CARLSON, Communication Systems, McGraw-Hill, 2002.
3. J.G. PROAKIS, Digital Communications, McGraw Hill, 2001.

Software

- Matlab