Universitat Autònoma de Barcelona

2019/2020

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

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

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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.

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	134.5	5.38	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 if NT> = 4.0
- NF = NT if NT <4.0

Obtaining the theory note (NT):

- For continuous evaluation: it consists of 4 tests throughout the course. A test of topics 1-2 (P1) of approximately 1 hour duration with a weight of 15% (12% on the final qualification), a test of topics 1-3 (P2) of approximately 2 hours duration with a weight of 35% (28% on the final grade), a test of topic 4 (P3) of approximately 1 hour duration with a weight of 15% (12% on the final qualification) and a test of the 4- 6 (P4) of approximately 2 hours lasting with a weight of 35% (28% of the final grade).
- For single assessment: final exam with a weight of 100% (80% of the final grade). It consists of two parts that are worth 50% (40% of the final grade) each, PF1 (subjects 1-3) and PF2 (subjects 4-6). The approximate duration of PF1 and PF2 is 2 hours each.
- Recovery of the continuous assessment tests: P1 and P2 tests will be recovered together in the final exam of the subject, part PF1, giving rise to 50% of the NT (40% of the final grade). Likewise, P3 and P4 tests will also be recovered together, part PF2, giving rise to the remaining 50% of the NT (40% of the final grade). Therefore, the student can retrieve tests P1 and P2 (50% NT), P3 and P4 (50% NT) or P1-P4 (100% NT).
- Use the recovery to improve the theoretical note: the student can submit to a part of the subject or both after having approved for continuous evaluation. In this case, the note that will be taken into account will

always be that of the final exam. However, you will be able to see the exam and, if it considers it appropriate, do not deliver so that the note obtained by continuous assessment is counted.

Obtain the practice 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 test (PLAB): written test of approximately 1 hour duration in which the work done in the four laboratory sessions is evaluated. It accounts for 70% of the NP practice mark (14% of the final grade).
- 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.

Programming of evaluation activities:

- The scheduling of the assessment 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 exam section.
- The final exam has a total duration of approximately 6.5 hours with the following timing: PF1 (approximately 2 hours) - Break (approx 0.5 hours) - PF2 (approx. 2 hours) - Break (approx. 1 hour) - PRLAB (approx 1 hour).

Evaluation of repeating students:

- No difference in the section of theory.
- Practices:

  The grade obtained in previous courses can be validated provided NP> = 5.0 and all the practice sessions have been completed.

  If a student with the possibility of validating the practices is re-enrolled in practices and is therefore evaluated by ALAB, PLAB, PRLAB (any combination), it is considered that he has chosen to be evaluated again. Therefore, in any case, the note obtained in previous calls will be taken into account.

Recovery process:

- The student can submit to the PF1, PF2 or PRLAB tests provided that they have been presented to a set of activities that represent a minimum of two thirds of the total grade of the subject.
- In the event that a student can not attend P1, P2, P3, P4 or PLAB tests for justified reasons, he must present the corresponding written, signed and stamped proof. In this case, the test in question may be evaluated with a rating of 0.0 not thereby preventing participation in the recovery process.
- With the recovery processes established in the subject, every student has the opportunity to be evaluated twice in each one of the evaluation activities except for the assistance to practices that is not recoverable. It is for this reason that no additional assessment tests will be carried out if a student can not attend one of the tests.

Procedure for the review of qualifications:

- For evaluation 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 can be made about the activity note, which will be evaluated by the teachers responsible for the subject. If the student does not submit to this review, this activity will not be reviewed later.
- In the event that a student can not attend a revision, they can request the teacher responsible for the subject to review their proof just finished the revision with the rest of the students. To do this, it is necessary: i) that the student make the request before the date and time of the revision certificate and ii) present supporting documents in writing, signed and sealed, with the reasons why he can not 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.
- A student will be considered non-evaluable (NA) if one of the following situations occurs:
  You do not get a minimum score of 0.5 in P2 or in its recovery, PF1.
  You do not get a minimum score of 0.5 in P4 or in its recovery, PF2.
  You do not get a minimum score of 0.5 in PF1.
  You do not get a minimum rating of 0.5 in PF2.

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, plagiarizing, cheating, copying, etc. in any of the assessment activities it will imply suspending it with a zero. Assessment activities qualified in this way and by this procedure will not be recoverable.
- It should be taken into account that the P1 and P2 tests are recovered together in the final exam, PF1 test, and therefore plagiarized in one of them does not allow the student to be assessed of PF1. The same thing happens with tests P3 and P4 and their recovery to PF2.

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
Exam 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
Final exam/recovery (PF1 - PF2)	80%	4	0.16	1, 4, 3, 13, 12, 19, 18, 10, 17
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 4 (P3)	12%	1	0.04	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial exam topics 1 and 2 (P1)	12%	1	0.04	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial exam topics 1, 2 and 3 (P2)	28%	2	0.08	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial exam topics 4, 5 and 6 (P4)	28%	2	0.08	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17

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.