Universitat Autònoma de Barcelona

2023/2024

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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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

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 engineer's 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 engineer's 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 one's 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

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. These sessions will be carried out with the support of SDR plates so that the students can experience what they see in theory. It is recommended to bring a laptop.

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	10	0.4	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	151.5	6.06	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; 4.9) and NT <4.0

Obtaining the theory note (NT):

- Through a continuous assessment process (NAC): consists of 2 test-type tests throughout the course with a weight of 50% on theory (40% on the final grade) and an approximate duration of 1.5 hours. They are distributed according to: 1 test of topics 1,2 and 3 (P1) and 1 test of topic 4 and 5 (P2).
- Recovery process: final test type exam (PR) with a weight of 100% on theory (80% on the final grade). All course content is included and lasts approximately 2 hours, where the NPR grade is obtained.

- Grade improvement in recovery: allowed. The theory mark remains NT = max(NAC, NPR). If recovery is not performed, NT=NAC.
- Additional score in NT: once NT has been calculated, according to the previous formula, if NT is >= 3.0, you can opt for an improvement in the NT score of up to 2 extra points. This improvement will come if the student has participated in the Competition/Collaboration Phase (FCC). This phase, completely voluntary, consists of a total of 6 1-hour(aprox) test-type tests in which different teams will compete against each other throughout the semester. Details of the NFCC grade calculation for this phase will be provided in the course's Moodle classroom. Students who do not participate in any activity will have their grade adjusted according to participation.

Obtaining the laboratory note (NP):

- Laboratory participation assistance (ALAB): accounts for 30% of the NP practice grade (6% on the final grade). This activity is not recoverable and the grade NALAB is obtained.
- Laboratory Challenge (RLAB): the laboratory of the subject will be based on the resolution of a communication challenge using the SDR boards. At the end of each session, the progress of each team will be evaluated. The average of the grades of the four sessions is calculated and this accounts for 70% of the NP practice grade (14% of the final grade). This grade is NRLAB and is also non-refundable.
- Laboratory Recovery: No recovery. The work is based on the resolution of the challenge carried out during the different sessions.
- NP grade improvement: not allowed.
- Obtaining NP: NP = 0.7*NRLAB + 0.3*NALAB.

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 (recovery) has a total duration of approximately 2 hours.

Evaluation of repeating students:

- No differences.

Recovery process:

- The student can take the PR test 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 an evaluation test, the current evalution regulations at the Escola d'Enginyeria will be applied.

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 on NAC.
  You do not get a minimum grade of 0.5 to PR.
  The student has not submitted a set of activities that represenst at least two thirds of thetotal 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 gualified 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 P1 and P2 tests are recovered jointly in the PR test, and therefore plagiarism in one of them does not allow the student to be eligible for PR.

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
Lab Challenge (RLAB)	14%	4	0.16	1, 2, 4, 3, 5, 13, 12, 19, 18, 6, 9, 8, 10, 7, 11, 14, 16, 15, 17, 23, 22, 21, 20
Partial Test Topics 4 and 5 (P2)	40%	1.5	0.06	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Partial test Topics 1, 2 and 3 (P1)	40%	1.5	0.06	1, 4, 3, 13, 12, 19, 18, 10, 16, 15, 17, 22
Recovery (PR)	80%	3	0.12	1, 4, 3, 13, 12, 19, 18, 10, 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.

Software

- Matlab
- SDR environment