COURSE SYLLABUS
2020-2021

GENERAL INFORMATION

Course information	
Name	Fundamentals of Telecommunications
Code	DEAC-MSG-512
Degree	Master in Smart Grids
Year	1st
Semester	1st (Fall)
ECTS credits	3 ECTS
Type	Compulsory
Department	Electronics, Control and Communications
Area	Communications
Coordinator	Javier Matanza Domingo

Instructor	
Name	Luís Cucala García
Department	Electronics, Control and Communications
Area	
Office	D-220 (Alberto Aguilera, 25)
e-mail	lcucala@comillas.edu
Phone	-
Office hours	Arrange an appointment through email.

DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

The aim of this course is to provide the student with the fundamental foundations on telecommunication that allow him to tackle more advance concepts. The course content does not assume any prior knowledge on telecommunications. However, students taking this course should have some previous engineering knowledge. More precisely, electrical or electronic engineering.

The course focuses not only on the transmissions systems and techniques used nowadays for transmitting information at a high level but it also elaborates on the fundamental concepts of signal modulation and propagation.

By the end of this course, the student will have a general understanding of telecommunication systems and techniques. The student will be familiar con concepts such as noise, bandwidth, capacity, multiplexation and the OSI layer paradigm. As a result, the students will be able to follow-up to courses with more advanced concepts in information transmission.

Prerequisites

Students willing to take this course should be familiar with linear algebra, basic probability and statistics, and undergraduate-level programming. Previous experience with MATLAB is also desired although not strictly required.

CONTENTS

Contents
Theory
BLOCK 1: FUNDAMENTALS OF INFORMATION TRANMISSION
Unit 1. Introduction
1.1 Introduction to the transmission of information 1.2 *Divide et impera*: OSI Layer stack 1.3 Packet Vs. Circuit switching
Unit 2. Application Layer's Functions
2.1 Main functions for the Application Layer 2.2 HTTP and FTP examples
Unit 3. Transport Layer's Functions
3.1 Connection-Oriented Vs. Non-Connection-Oriented transmissions 3.2 Segmentation and Reassembly 3.3 Flow control: Sliding Window 3.4 Error Control: ARQ, go-back-N, Stop and Wait, and Selective Retransmission 3.5 TCP Vs. UDP
Unit 4. Network Layer's Functions
4.1 Fundamental Routing Functions 4.2 Network Resolution 4.3 IPv4 Vs. IPv6
Unit 5. Medium Access Functions
5.1 ALOHA 5.2 CSMA / CD / CA
Unit 6. Internet Stack
6.1 TCP/IP 6.2 ARP 6.3 Examples for common applications
BLOCK 2: FUNDAMENTALS OF SIGNAL TRANMISSION
Unit 7. Signals and Linear Systems
7.1 Analog Vs. Digital Signals 7.2 Linear Systems 7.3 Fourier Series and Fourier Transform for analog signals
Unit 8. Sampling and Digitalization
8.1 Sampling 8.2 Quantization and Quantization Noise 8.3 Fourier Transform for digital signals
Unit 9. Fundamental Modulation Techniques
9.1 Modulation for analog signals: AM / FM 9.2 Electronic Noise 9.3 Modulation for digital signals: Base-Band and Pass-Band modulations 9.4 Signal-to-Noise Ratio and Bit-Error Rate
Unit 10. Multiplexing Systems
10.1 FDM 10.2 TDM 10.3 CDM

Laboratory
Lab 1. TCP/IP
In this first session, students will user a common software tool when trying to sniff the traffic in a communication network: Wireshark. This tool will be used to analyze the traffic generated in a laboratory LAN.
Lab 2. Matlab for Signal Processing
The aim of this session is that students become familiar with one of the tools that they will be using throughout the course: Matlab. Even if they are already familiar in general with the tool, this session will focus on how it can be used for signal processing thanks to the built-in libraries.
Lab 3. Sampling and Quantization
In the third lab session, students will use the previously acquire skills with Matlab to implement an ideal sampler. They will become familiar with concepts studied in theory such as the aliasing effect and the quantization noise.
Lab 4. Analog Modulation and Spectral Analysis
In the final session, students will leave the abstraction of software tools to perform some electrical experiments on modulation. During this session, the use of the Spectrum Analyzer will be introduced.

Competences and learning outcomes

Competences	
C1.	Have a fundamental knowledge of digital communication techniques.
C2.	Understand the trade-offs in digitalizing signals and the most common techniques to perform the digitalization.
C3.	Have a fundamental knowledge of linear systems and how they are useful when modeling a communication link.
C4.	Have a well-based understanding of the OSI-layer structure for machine-to-machine communications.

Learning outcomes

By the end of the course students should:

LO1. Demonstrate fundamental knowledge and fundamentals of the principles that underpin the operation of packet-based communication networks.

LO2. Prove a fundamental knowledge of digitalization of analog signals and the corresponding processing for their transmissions.

LO3. Recognize the fundamental modulation techniques for analog and digital signals and their corresponding figures of merit.

TEACHING METHODOLOGY

General methodological aspects	
Out-of-class activities	**Competences**
▪ **Lectures**: The lecturer will introduce the fundamental concepts of each chapter, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing short application exercises to be solved in class either on paper or using a software package	C1, C2, C3, C4
▪ **Lab sessions:** Under the instructor's supervision, students, divided in small groups, will apply the concepts and techniques covered in the lectures.	C1, C2, C3, C4
Out-of-class activities	**Competences**
▪ Personal study of the course material and resolution of the proposed exercises.	C1, C2, C3, C4
▪ Lab session preparation to make the most of in-class time.	C1, C2, C3, C4
▪ Lab results analysis and report writing.	C1, C2, C3, C4

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Quizzes	▪ Understanding of the theoretical concepts.	20%
Final exam	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving.	50%
Lab assignments	▪ Application of theoretical concepts to real problem-solving. ▪ Written communication skills.	30%

GRADING AND COURSE RULES

Grading

Regular assessment

- **Theory** will account for 70%, of which:
  - Quizzes: 20%
  - Final exam: 50%
- **Lab** will account for the remaining 30%

In order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the laboratory mark must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Retake

Lab marks will be preserved as long as the weighted average of all the sessions results in a passing grade. Otherwise a new lab reports will be handed in. It is up to the professor criteria to modify the content of the laboratory sessions so that they are not the same as the ones developed over the course. In addition, all students will take a final exam. The resulting grade will be computed as follows:

- **Theory** will account for 70%, of which:
  - Quizzes: 20%
  - Final exam: 50%
- **Lab** will account for the remaining 30%, of which:

As in the regular assessment period, in order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the mark of the laboratory must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Académicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:
  - Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
  - Regarding laboratory, absence to more than 15% of the sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Missed sessions must be made up for credit.
- Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE

The work plan and schedule will be presented the first day of lesson.

BIBLIOGRAPHY

Basic bibliography

- Slides prepared by the lecturer (available in Moodle).

Complementary bibliography

- Discrete-Time Signal Processing (2nd Edition). Oppenheim, Schafer, Buck. Prentice-Hall.
- Digital Signal Processing Handbook. Vijay K. Madisetti, Douglas B. Williams. Chapman & Hall
- Alan V. Oppenheim. Signals and Systems
- J. D. Sherrick. Concepts in Systems and Signals, Prentice-Hall
- Digital & Analog Communication Systems, 7th edition. Leon W. Couch. Prentice Hall.