

Course Unit	Telecommunications		Field of study	Telecommunications and Signal Processing	
Bachelor in	Electrical and Computers Engineering		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	2	Level	1-2
Type	Semestral	Semester	2	ECTS credits	6.0
Workload (hours)			162	Contact hours	
			T	30	TP
			PL	30	TC
			S	-	E
			OT	-	O
			Code 9112-742-2205-00-23		

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) João Paulo Coelho

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Understand the concepts and physical constraints behind distance communication processes using electrical signals.
2. Design stages and electronic circuits for RF amplification, mixing and impedance matching operations.
3. Simulate the radiation pattern emitted by antennas using EM software
4. Analyze the dynamic behaviour of transmission lines under RF regime.
5. Understand the communication process in different types of technologies for information transmission. Namely, mobile, computer and satellite communication networks.

### Prerequisites

Before the course unit the learner is expected to be able to:

1. Solve basic linear differential equations.
2. Analyze AC and DC circuits.
3. Apply the Fourier and Laplace transforms.
4. Matlab programming or another equivalent numerical computing language.

### Course contents

Electromagnetic waves. Amplification, filtering and mixing of signals. Antennas. Transmission lines. Modulation and demodulation. Digital transmission.

### Course contents (extended version)

1. Electromagnetic Waves
  - General concepts on waves
  - Maxwell equations and electromagnetic radiation
  - Electromagnetic wave energy
  - Standing waves
  - Electromagnetic radiation spectrum
  - Wireless communication systems
2. Antennas
  - Attenuation, propagation and polarization
  - Radiative and reactive EM fields
  - Friis equations and Fresnel region
  - Radiation pattern and link budget
  - Radio and radar equations
  - Antenna impedance
  - Analysis of common antenna types: monopole, dipole and loop
  - Emergent technologies: Phase arrays
3. Transmission lines
  - Reactive elements
  - Transmission lines electrical model
  - Reflexion and losses
  - Impedance matching
4. Amplifiers, Mixers and Oscillators
  - PI model for the MOSFET
  - Types of amplifiers
  - Low-noise and power amplifiers
  - Types of mixers
  - Double-balanced and ring mixers
  - Oscillators and PLL
5. Modulation and demodulation
  - Amplitude modulation
  - Angle modulation
  - Other modulation techniques: QPSK and QAM
6. Digital transmission
  - Formats for digital transmission
  - Line coding
  - Case studies: serial, I2C, SPI and IrDA

### Recommended reading

1. Communication Systems, 5th Edition; A. Bruce Carlson, Paul B. Crilly; McGraw-Hill, 2009
2. Digital Telephony, 3rd Edition; Bellamy, J. C. ; John Wiley and Sons, 2000
3. Telecommunications Engineering, 3rd edition; J. Dunlop, D. G. Smith; Stanley Thornes, 1998
4. Mobile Communications, 2nd Edition; J. Schiller; Addison-Wesley, 2003
5. Practical Antenna Handbook, 4th Edition, J. J. Carr, McGraw-Hill, 2001

### Teaching and learning methods

Theoretical- Practical (TP) classes where the subjects are presented using several audiovisual resources. Laboratory classes where a set of experiments, according to the concepts introduced in the TP classes, will be performed.

**Assessment methods**

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
  - Practical Work - 50% (Laboratory exam to take place in the last week of the semester.)
  - Final Written Exam - 50% (Written exam to take place on a date and time defined by the school.)
2. Alternative 2 - (Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 50% (Written exam to take place on a date and time defined by the school.)
  - Practical Work - 50% (Laboratory examination is to take place simultaneously with the written test.)

**Language of instruction**

Portuguese

**Electronic validation**

João Paulo Coelho	José Augusto de Almeida Pinheiro Carvalho	José Luís Sousa de Magalhaes Lima	José Carlos Rufino Amaro
19-02-2024	26-02-2024	27-02-2024	02-03-2024