

# TELECOMMUNICATIONS SYSTEMS ENGINEERING B. Eng.

## SEMESTER 4

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**Year 2015/16**

<b>Course Name:</b>	Science, Technology and Society	<b>Course Code:</b>	595000317
<b>Year:</b>	2	<b>Semester:</b>	4
<b>Credits (ECTS):</b>	3	<b>Credit Hours:</b>	2
<b>Area:</b>	Common UPM Skills	<b>Type:</b>	Basic / Required
<b>Term:</b>	Spring	<b>Language:</b>	Spanish
<b>Prerequisites / Co-requisites:</b>		None	
<b>Coordinator:</b>		Eloy Portillo	
<b>Bachelor Engineering Program:</b>		Telecommunications Systems Engineering Communications Electronics Engineering Sound and Image Engineering Telematics Engineering	

### Course Contents

1. Printing, Renaissance and first globalization
2. Scientific spirit and ingenuity Machinist
3. The scientific revolution
4. The revolutions of the 18th century
5. Progress and development capitalists
6. Technological determinism and ethics in engineering
7. Telecommunications economy
8. Environmental crisis and "grey ecology"
9. Sociology of telecommunications
10. Critical theory of postmodernism

### ABET Student Outcomes

- (d) An ability to function on multidisciplinary teams
- (f) An understanding of professional and ethical responsibility
- (g) An ability to communicate effectively
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) A recognition of the need for, and an ability to engage in life-long learning

### Study Outcomes. (according to the Spanish program definition)

- CG 02 Ability to search and select information, develop critical thinking and produce and defend arguments within the area.
- CG 03 Ability to express oneself in oral and written form, and to convey information through documents and public presentations.

- CG 05 Ability for teamwork in multidisciplinary environments.
- CG 06 Ability for adaptability, negotiation, conflict resolution and leadership.
- CG 09 Ability to analyze and assess the social and environmental impact of technical solutions..
- CE B3 Knowledge and command of basic concepts on the general laws of Mechanics, Thermodynamics, electromagnetic fields and waves, and its application to solve engineering problems.
- CE TEL 03 Ability to use computer tools of search of bibliographical resources or of information related to the telecommunications and the electronics.
- CE TEL 16 Knowledge of telecommunication legislation and regulations at the National, European and International levels.

**Specific outcomes of instruction (according to the Spanish program definition)**

- 1.- Locate the required information correctly.
- 2.- Analyze the information found and discard the irrelevant.
- 3.- Process the information from different sources and synthesize it properly.
- 4.- Contrast the ideas contributed by different sources.
- 5.- -Make an assessment about the rigor of the source of origin of information.
- 6.- Relate the scientific and technological aspects with a social environment of increasing complexity: social, economic, political, legal, ethical and environmental aspects.

**Bibliography**

“Ciencia, tecnología y sociedad. Una introducción al estudio social de la ciencia y la tecnología”, González, M. I.; López Cerezo, J. A. y Luján, J. L., 1996.

**Year 2015/16**

<b>Course Name:</b>	Wave Propagation	<b>Course Code:</b>	595000318
<b>Year:</b>	2	<b>Semester:</b>	4
<b>Credits (ECTS):</b>	4,5	<b>Credit Hours:</b>	3
<b>Area:</b>	Physics	<b>Type:</b>	Basic / Required
<b>Term:</b>	Fall / Spring	<b>Language:</b>	Spanish
<b>Prerequisites / Co-requisites:</b>	Calculus I Lineal Algebra Calculus II Electromagnetism and Waves		
<b>Coordinator:</b>	Emma Acosta		
<b>Bachelor Engineering Program:</b>	Telecommunications Systems Engineering Communications Electronics Engineering Sound and Image Engineering Telematics Engineering		

### Course Contents

1. Vector operators
2. Plane acoustic waves
3. Spherical acoustic waves
4. Stationary acoustic waves
5. Maxwell equations. Wave equation. Energy
6. Propagation of electromagnetic waves in a dielectric medium
7. Propagation of electromagnetic waves in conductive media
8. Reflection and refraction
9. Guided waves
10. Radiation of electromagnetic waves

### ABET Student Outcomes

- (a) An ability to apply knowledge of mathematics, science, and engineering
- (b) An ability to design and conduct experiments, as well as to analyze and interpret data
- (d) An ability to function on multidisciplinary teams

### Study Outcomes (according to the Spanish program definition)

- CG 03 Ability to express oneself in oral and written form, and to convey information through documents and public presentations.
- CG 04 Ability to abstract, analyze, and synthesize, and to solve problems.
- CG 13 Learning skills with a high degree of autonomy.

- CE B3 Knowledge and command of basic concepts on the general laws of Mechanics, Thermodynamics, electromagnetic fields and waves, and its application to solve engineering problems.
- CE TEL 09 Ability to understand the mechanisms of electromagnetic and acoustic wave propagation and transmission, as well as corresponding transmitters and receivers.

**Specific outcomes of instruction (according to the Spanish program definition)**

1. Analyze fundamental characteristics of wave propagation.
2. Analyze the phenomenology associated with the electrostatic field.
3. Analyze the propagation of electromagnetic waves in media dielectrics and conductors.
4. Understand and analyze the meaning of Maxwell's equations and its consequences.
5. Understand the basic properties of materials that are based on devices.
6. Analyze the key characteristics of the magnetic field.
7. Analyze the phenomenology associated with oscillations.
8. Analyze fundamental characteristics of electromagnetic fields and electromagnetic waves.
9. Analyze the effect of boundary conditions, as well as the guided electromagnetic wave propagation.
10. Analyze the phenomena associated with radiation.
11. Analyze flat and spherical acoustic waves in media limited and unlimited.

**Bibliography**

“Elementos de electromagnetismo”, Matthew N. O., Sadiku Edición 3ª, Editorial Oxford University Press.

“Fundamentos de la teoría electromagnética”, Reitz, Milford y Christy, Editorial Pearson Educación.

“Campos y ondas electromagnéticos”, P. Lorrain y D:R: Corson, Editorial Selecciones Científicas.

“Fundamentos de Acústica”, L.E. Kinsler, A.R. Frey, A.B. Coppens y J.V., Sanders. Editorial Limusa.

**Year 2015/16**

<b>Course Name:</b>	Microprocessors	<b>Course Code:</b>	595000320
<b>Year:</b>	2	<b>Semester:</b>	4
<b>Credits (ECTS):</b>	6	<b>Credit Hours:</b>	4
<b>Area:</b>	Fundamentals of Electronics	<b>Type:</b>	Basic / Required
<b>Term:</b>	Fall / Spring	<b>Language:</b>	Spanish
<b>Prerequisites / Co-requisites:</b>		Programming I Electronics I	
<b>Coordinator:</b>		Juan Manuel López	
<b>Bachelor Engineering Program:</b>		Telecommunications Systems Engineering Communications Electronics Engineering Sound and Image Engineering Telematics Engineering	

### Course Contents

1. Introduction to microprocessor systems
2. Processor Cortex M0
3. Programming techniques

### ABET Student Outcomes

- (b) An ability to design and conduct experiments, as well as to analyze and interpret data
- (d) An ability to function on multidisciplinary teams
- (e) An ability to identify, formulate, and solve engineering problems
- (f) An understanding of professional and ethical responsibility
- (g) An ability to communicate effectively
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) A recognition of the need for, and an ability to engage in life-long learning
- (j) A knowledge of contemporary issues
- (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

### Study Outcomes (according to the Spanish program definition)

- CG 02 Ability to search and select information, develop critical thinking and produce and defend arguments within the area.
- CG 03 Ability to express oneself in oral and written form, and to convey information through documents and public presentations.
- CG 04 Ability to abstract, analyze, and synthesize, and to solve problems.

- CG 05 Ability for teamwork in multidisciplinary environments.
- CG 11 Skills for the use of Information and Communication Technologies.
- CG 13 Learning skills with a high degree of autonomy.
- CE B2 Basic knowledge on using and programming computers, operating systems, databases and software used in engineering.
- CE B4 Knowledge and command of basic concepts on linear systems and related functions and transforms, theory of electrical circuits, electronic circuits, physical principles of semiconductors and logic families, electronic and photonic devices, materials technology and its application for solving problems of engineering.
- CE TEL10 Ability to analyze and design combinational and sequential circuits, synchronous and asynchronous, and to use microprocessors and integrated circuits.

**Specific outcomes of instruction (according to the Spanish program definition)**

1. Use the microprocessor peripherals to develop applications which solve problems of medium complexity.
2. Design the logic necessary to connect memory and peripherals for input/output in a digital system based on microprocessor, respecting the timing established in their machine cycles.
3. Perform simple programs in Assembly language and high level for a commercial microprocessor Language:.
4. Understand the functionality and interface subsystems combinational, sequential, and memories.
5. Understand the principles of operation of some basic peripherals: serial port, parallel port, timers, etc.
6. Learn about the architecture, features, and operation of a commercial microprocessor.
7. Understand the different techniques of input/output for the exchange of data between a microprocessor-based system and other systems.
8. Understand the principles of operation of a microprocessor, the basic elements that make up its architecture, and digital circuits comprising a microprocessor-based system.

**Bibliography**

"Manual del procesador Cortex-M0"



**Year 2015/16**

<b>Course Name:</b>	Communication Theory	<b>Course Code:</b>	595000321
<b>Year:</b>	2	<b>Semester:</b>	4
<b>Credits (ECTS):</b>	6	<b>Credit Hours:</b>	4
<b>Area:</b>	Communication Systems	<b>Type:</b>	Basic / Required
<b>Term:</b>	Fall / Spring	<b>Language:</b>	Spanish
<b>Prerequisites / Co-requisites:</b>		Signals and Systems	
<b>Coordinator:</b>		Pedro García	
<b>Bachelor Engineering Program:</b>		Telecommunications Systems Engineering Communications Electronics Engineering Sound and Image Engineering Telematics Engineering	

### Course Contents

1. Model of a communication system
2. Signals
3. Noise
4. Distortion
5. Analog Modulation
6. A/D Conversion. MIC System
7. Filtered Base-band digital transmission
8. Base band Digital transmission with noise
9. Digital Modulation

### ABET Student Outcomes

- (b) An ability to design and conduct experiments, as well as to analyze and interpret data
- (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (e) An ability to identify, formulate, and solve engineering problems
- (g) An ability to communicate effectively
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) A recognition of the need for, and an ability to engage in life-long learning
- (j) A knowledge of contemporary issues
- (k) An ability to use the techniques, skills, and modern engineering tools necessary for

engineering practice.

### **Study Outcomes (according to the Spanish program definition)**

- CG 02 Ability to search and select information, develop critical thinking and produce and defend arguments within the area.
- CG 04 Ability to abstract, analyze, and synthesize, and to solve problems.
- CG 05 Ability for teamwork in multidisciplinary environments.
- CG 09 Ability to analyze and assess the social and environmental impact of technical solutions..
- CG 11 Skills for the use of Information and Communication Technologies.
- CE TEL 01 Capacidad para aprender de manera autónoma nuevos conocimientos y técnicas adecuados para la concepción, el desarrollo o la explotación de sistemas y servicios de telecomunicación.
- CE TEL 03 Ability to use computer tools of search of bibliographical resources or of information related to the telecommunications and the electronics.
- CE TEL 04 Ability to analyze and specify the fundamental parameters of a communication system.
- CE TEL 05 Ability to weigh up the advantages and disadvantages of different technological alternatives to deploy or implement communication systems, from the point of view of signal space, perturbations and noise, and analog and digital modulation systems.gical and digital modulation.
- CE TEL10 Ability to analyze and design combinational and sequential circuits, synchronous and asynchronous, and to use microprocessors and integrated circuits.
- CE TEL 16 Knowledge of telecommunication legislation and regulations at the National, European and International levels.

### **Specific outcomes of instruction (according to the Spanish program definition)**

- 1.- Relate the technical aspects with the social environment. Aspects of market, regulatory environment.
- 2.- Analyze the process of modulation and demodulation, analog and digital.
- 3.- Interpret and characterize the signal parameters in terms of power, wide bandwidth and quality of telecommunication systems (relations signal to noise or interference, distortion and error probability).
- 4.- Analyze the structure, performance and applications of telecommunication systems.
- 5.- Characterizing elements and technologies of transit, distribution, access and user networks.
- 6.- Understand and manage base-band and modulated signals.

### **Bibliography**

“Apuntes de Teoría”, Dpto. Publicaciones.

“Manual de Practicas”, Dpto. Publicaciones.

“Libro de Problemas”, Dpto. Publicaciones.

**Year 2015/16**

<b>Course Name:</b>	Analog Electronics	<b>Course Code:</b>	595000322
<b>Year:</b>	2	<b>Semester:</b>	4
<b>Credits (ECTS):</b>	6	<b>Credit Hours:</b>	4
<b>Area:</b>	Analog Electronics	<b>Type:</b>	Basic / Required
<b>Term:</b>	Spring	<b>Language:</b>	Spanish
<b>Prerequisites / Co-requisites:</b>		Circuits Analysis I Electronics I	
<b>Coordinator:</b>		Francisco José Arqués	
<b>Bachelor Engineering Program:</b>		Telecommunications Systems Engineering	

### Course Contents

1. Introduction to electronic components
2. Polarizing techniques
3. Equivalent models of transistors
4. Middle frequency and small signal amplifiers
5. Frequency Response
6. Introduction to feedback amplifiers.

### ABET Student Outcomes

- (b) An ability to design and conduct experiments, as well as to analyze and interpret data
- (d) An ability to function on multidisciplinary teams
- (g) An ability to communicate effectively
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (j) A knowledge of contemporary issues
- (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

### Study Outcomes (according to the Spanish program definition)

- CE B1 Ability to solve mathematic problems that may come up in engineering. Ability to apply knowledge on: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations, partial-differential equations, numeric methods, numeric algorithmics, statistics and optimization.
- CE B2 Basic knowledge on using and programming computers, operating systems, databases and software used in engineering.
- CE B4 Knowledge and command of basic concepts on linear systems and related functions and transforms, theory of electrical circuits, electronic circuits,

physical principles of semiconductors and logic families, electronic and photonic devices, materials technology and its application for solving problems of engineering.

- CE CE04 Ability to apply electronic as support technology in other fields and activities, not only in the field of Information Technologies and Communications.
- CE CE05 Ability to design circuits of analogical and digital electronics, circuits of analogical-digital and digital-analogical conversion, radiofrequency circuits and conversion of electric power for applications of telecommunication and computing.
- CE CE08 Ability to specify and use electronic instrumentation and measurement systems.
- CE ST03 Ability to analyze components and their specifications for guided and non-guided communication systems.
- CG 02 Ability to search and select information, develop critical thinking and produce and defend arguments within the area.
- CG 04 Ability to abstract, analyze, and synthesize, and to solve problems.
- CG 11 Skills for the use of Information and Communication Technologies.

### **Specific outcomes of instruction (according to the Spanish program definition)**

- 1.- Define the discrete transformed of Fourier (DFT).
- 2.- Relate the elementary concepts of electromagnetism and electrical circuits.
- 3.- Relate the DFT with other transformations: Fourier transform, Fourier Series development.
- 4.- Understand the characteristics of the diodes, bipolar and unipolar transistors used in electronic circuits.
- 5.- Understand the usefulness of the simulation of analog circuits based on diodes, transistors and operational amplifiers.
- 6.- Applying basic circuit analysis techniques to analyze the functioning of basic circuits with transistors.
- 8.- Understand the model behavior of bipolar and unipolar transistors, in working conditions of small signal level.
- 9.- Understanding bipolar and unipolar transistors graphically and analytical in continuous.
- 10.- Meet the Thevenin and Norton theorems, the simplifications which they give place and know to determine the equivalent which they generate.
- 12.- Relate time continuous signals and time discrete in frequency domain signals.
- 13.- Relate time continuous signals and time discrete time-domain signals.

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"Electrónica" ALLAN R. HAMBLEY , PEARSON EDUCACION, 2001.

ELECTRONICA DE POTENCIA: CIRCUITOS, DISPOSITIVOS Y APLICACIONES". MUHAMMAD H. RASHID , PRENTICE HALL MEXICO, 2005

"Principles of Transistor Circuits". S W Amos. ELSEVIER.

"Intuitive Analog Circuit Design", Marc Thompson. ELSEVIER.

Electrónica Básica para Ingenieros. Gustavo A. Ruiz Robredo. Servicio de Publicaciones de la Universidad de Cantabria

**Year 2015/16**

<b>Course Name:</b>	Digital Signal Processing	<b>Course Code:</b>	595000324
<b>Year:</b>	2	<b>Semester:</b>	4
<b>Credits (ECTS):</b>	4,5	<b>Credit Hours:</b>	3
<b>Area:</b>	Communication Systems	<b>Type:</b>	Basic / Required
<b>Term:</b>	Fall / Spring	<b>Language:</b>	Spanish
<b>Prerequisites / Co-requisites:</b>		Calculus I, Lineal Algebra Calculus II, Signals and Systems	
<b>Coordinator:</b>		Juan Carlos Gonzalez de Sande	
<b>Bachelor Engineering Program:</b>		Telecommunications Systems Engineering Communications Electronics Engineering Sound and Image Engineering Telematics Engineering	

### Course Contents

1. Continuous digital signal processing
2. Design of digital filters
3. The transform discrete Fourier transform (DFT)

### ABET Student Outcomes

- (a) An ability to apply knowledge of mathematics, science, and engineering
- (b) An ability to design and conduct experiments, as well as to analyze and interpret data
- (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) An ability to function on multidisciplinary teams
- (g) An ability to communicate effectively
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) A recognition of the need for, and an ability to engage in life-long learning
- (j) A knowledge of contemporary issues

### Study Outcomes (according to the Spanish program definition)

- CG 02 Ability to search and select information, develop critical thinking and produce and defend arguments within the area.
- CG 03 Ability to express oneself in oral and written form, and to convey information through documents and public presentations.
- CG 04 Ability to abstract, analyze, and synthesize, and to solve problems.
- CE B4 Knowledge and command of basic concepts on linear systems and related functions and transforms, theory of electrical circuits, electronic circuits,

physical principles of semiconductors and logic families, electronic and photonic devices, materials technology and its application for solving problems of engineering.

CE TEL04 Ability to analyze and specify the fundamental parameters of a communication system.

CE TEL08 Ability to apply signal analysis and treatment and system modeling tools.

### **Specific outcomes of instruction (according to the Spanish program definition)**

- 1.- Perform the convolution of signals.
- 2.- An analysis on frequency of discrete time signals.
- 3.- Linking continuous time systems and systems of discrete time in the time domain.
- 4.- Performing basic operations with signals and functions.
- 5.- Be able to characterize LTI systems of discrete time in the time domain (response to the impulse and constant coefficients linear difference equation) and processed domains (frequency and function of system response).
- 6.- Describe the characteristics of the spectral estimation of sequences with the spectrum of the continuous-time signal from which they come.
- 7.- Characterize and describe mathematically FIR and IIR filters.
- 8.- Designing IIR filters using the bilinear transformation method.
- 9.- Apply the rational change of the sample rate to the solution of problems.
- 10.- Mathematical tools of analysis and design for discrete time systems .
- 11.- Represent the flowchart of digital filters in their basic forms.
- 12.- Determine the parameters of an interpolator.
- 13.- Characterize mathematically the operation of sampling of continuous-time signals.
- 14.- Analysis and characterization of discrete time signals.
- 15.- Calculate the ideally sampled signal spectrum.
- 16.- Relate time continuous signals and time discrete time-domain signals.
- 17.- Relate the linear convolution with the DFT.
- 18.- Differentiate digital according to the characteristics of its impulse response filter types: FIR and IIR filters.
- 19.- Be able to describe the block diagram of a digital signal processing system in real time enumerating the significant parameters of each block.
- 20.- Describe the basic methods for the design of FIR filters.
- 21.- Describe linear phase FIR filters.
- 22.- Describe the principles of the method of sampling in frequency of FIR filter design and relate it to the DFT.
- 23.- Designing IIR filters by using the method of the invariant transformation of impulse.
- 24.- Determine the parameters of a decimator.
- 25.- Consider the solution to problems of sampling rate change.
- 26.- Relate the circular convolution with the DFT.

### **Bibliography**

"Señales y Sistemas", A.V. Oppenheim, A. S., Willsky y S. H. Nawab. Prentice Hall. 2000.

"Tratamiento de Señales en Tiempo Discreto", Oppenheim, Schaffer, Buck., Prentice Hall, 2000.

"Tratamiento digital de señales. Principios, algoritmos y aplicaciones", J.G. Proakis, D.G. Manolakis, , Prentice Hall, 1997.