Ministry of Higher Education and Scientific Research
National Pedagogical Committee for Science and Technology

HARMONIZATION
TRAINING OFFER
ACADEMIC MASTERS

2016 - 2017

Domain	Sector	Speciality
science and Technology	***Telecommunications***	***Telecommunications Systems***

Ministry of Higher Education and Scientific Research
National Pedagogical Committee for Science and Technology

مواءمة

عرض تكوين
ماستر أكاديمي

2017-2016

الميدان	الفرع	التخصص
علوم و تكنولوجيا	اتصالات سلكية و لا سلكية	أنظمة الاتصالات

Access conditions

(Indicate the license specialties that can give access to the Master's)

Sector	Harmonized master	Licenses giving access to the master	Classification according to license compatibility	Coefficient assigned to the license
Telecommunications	Telecommunications systems	Telecommunications	**1**	**1.00**
		Electronic	**2**	**0.80**
		Biomedical genius	**3**	**0.70**
		Automatic	**3**	**0.70**
		Other licenses These of the ST domain	**5**	**0.60**

Half-yearly organization sheets for the teaching of the specialty

Semester 1

Teaching unit	Materials Entitled	Credits	Coefficient	Hourly volume weekly Course	 TD	 TP	Semester Hourly Volume (15 weeks)	Complementary Work in Consultation (15 weeks)	Assessment method Continuous monitoring	 Review
Fundamental EUCode: UEF 1.1.1 Credits: 10 Coefficients: 5	Advanced digital communications	6	3	3:00	1h30		67:30	82:30	40%	60%
	Random Signals and Stochastic Processes	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EUCode: UEF 1.1.2 Credits: 8 Coefficients: 4	Radiocommunication	4	2	1h30	1h30		45:00	55:00	40%	60%
	FPGA Programmable Circuits	4	2	1h30	1h30		45:00	55:00	40%	60%
EU Methodology Code: UEM 1.1 Credits: 9 Coefficients: 5	TP Advanced digital communications	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	TP Random signals and Stochastic processes	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	TP Programmable circuits FPGA	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	Object-oriented programming in C++	3	2	1h30		1h00	37:30	37:30	40%	60%
Discovery Unit Code: UED 1.1 Credits: 2 Coefficients: 2	Basket of your choice	1	1	1h30			10:30 p.m.	02:30		100%
	Basket of your choice	1	1	1h30			10:30 p.m.	02:30		100%

EUTransversal Code: UET 1.1 Credits: 1 Coefficients: 1	Technical English and Terminology	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 1		**30**	**17**	**1:30 p.m.**	**6:00 a.m.**	**5:30**	**375h00**	**375h00**		

Semester 2

Teaching unit	Materials Entitled	Credits	Coefficient	Hourly volume weekly Course	 TD	 TP	Semester Hourly Volume (15 weeks)	Complementary Work in Consultation (15 weeks)	Assessment method Continuous monitoring	 Review
Fundamental EUCode: UEF 1.2.1 Credits: 10 Coefficients: 5	Digital signal processing	6	3	3:00	1h30		67:30	82:30	40%	60%
	Antennas	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EUCode: UEF 1.2.2 Credits: 8 Coefficients: 4	Transmission channels	4	2	1h30	1h30		45:00	55:00	40%	60%
	Coding and Compression	4	2	1h30	1h30		45:00	55:00	40%	60%
EU Methodology Code: UEM 1.2 Credits: 9 Coefficients: 5	TP Digital signal processing	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	TP Antennas And Canals oftransmission	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	TP Coding and Compression	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	Image processing	3	2	1h30		1h00	37:30	37:30	40%	60%
Discovery Unit Code: UED 1.2 Credits: 2 Coefficients: 2	Basket of your choice	1	1	1h30			10:30 p.m.	02:30		100%
	Basket of your choice	1	1	1h30			10:30 p.m.	02:30		100%
EUTransversal Code: UET 1.2 Credits: 1 Coefficients: 1	Ethics, deontology and intellectual property	1	1	1h30			10:30 p.m.	02:30		100%

Total semester 2		**30**	**17**	**1:30 p.m.**	**6:00 a.m.**	**5:30**	**375h00**	**375h00**		

Semester 3

Teaching unit	Materials Entitled	Credits	Coefficient	Hourly volume weekly Course	 TD	 TP	Semester Hourly Volume (15 weeks)	Complementary Work in Consultation (15 weeks)	Assessment method Continuous monitoring	 Review
Fundamental EUCode: UEF 2.1.1 Credits: 10 Coefficients: 5	Wireless networks and mobile networks	6	3	3:00	1h30		67:30	82:30	40%	60%
	Optical Communications	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EUCode: UEF 2.1.2 Credits: 8 Coefficients: 4	Multimedia Technology and Protocols	4	2	1h30	1h30		45:00	55:00	40%	60%
	RF and Microwave (Passive/Active) Devices	4	2	1h30	1h30		45:00	55:00	40%	60%
EU Methodology Code: UEM 2.1 Credits: 9 Coefficients: 5	TP Wireless networks and mobile networks	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	TP Optical communications	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	Technology and protocols for multimedia	2	1			1h30	10:30 p.m.	11:30 p.m.	100%	
	Digital TV	3	2	1h30		1h00	37:30	37:30	40%	60%
Discovery Unit Code: UED 2.1 Credits: 2 Coefficients: 2	Basket of your choice	1	1	1h30			10:30 p.m.	02:30		100%
	Basket of your choice	1	1	1h30			10:30 p.m.	02:30		100%
EUTransversal Code: UET 2.1 Credits: 1 Coefficients: 1	Documentary research and dissertation design	1	1	1h30			10:30 p.m.	02:30		100%

Total semester 3		**30**	**17**	**1:30 p.m.**	**6:00 a.m.**	**5:30**	**375h00**	**375h00**		

Discovery Teaching

Unit*(S1, S2 and S3)Selected*

subjects

1. Electromagnetic compatibility (Chosen material for S1)
2. Standards and Protocols (Chosen Subject for S1)
3. Embedded systems and telecommunications (Chosen subject for S2)
4. Radar Techniques (Chosen Subject for S2)
5. Space Telecommunication (Chosen Subject for S3)
6. Radio navigation system (Chosen material for the S3)

Free choice of subjects

7. Linux system
8. Operator networks
9. Satellite networks
10. Wireless sensor networks
11. Field networks
12. Emerging areas of optical telecommunications
13. Installation and maintenance of fiber optics
14. Radio Engineering
15. *VSAT Technology*
16. Propagation of acoustic microwaves in piezoelectric solids
17. RF and microwave measurements
18. Portable micro-antennas
19. Emerging telecommunication systems
20. Theoretical physics of optical and microwave analogies
21. Biological Effects of Electromagnetic Waves (Bio Electromagnetism)
22. Routing and access networks
23. CAD of telecom circuits
24. Characterization of RF devices
25. Web programming
26. Others...

Semester 4

Internship in a company sanctioned by a dissertation and a defence.

	VHS	coeffi cient	Credits
Personal work	550	09	18
Company internship	100	04	06
Seminars	50	02	03
Other (Framing)	50	02	03
Total Semester 4	750	17	30

This table is given for information only.

Evaluation of the End of Master Cycle Project

- Scientific value (Jury assessment) /6
- Dissertation writing (Jury assessment) /4
- Presentation and answer to questions (Jury assessment) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Jury assessment) /3

I - Detailed program by subject of the semester S1

Semester: 1
Course Unit: UEF 1.1.1 Subject 1:
Advanced digital communications
VHS: 67h30 (Course: 3h00, TD: 1h30)
Credits: 6
Rating: 3

Teaching objectives:

At the end of this course, the student will be able to identify the functions performed in advanced digital communication systems. This subject covers the various notions of non-ideal channels, multiple access techniques and MIMO systems.

Recommended prior knowledge:

Basic notions on thetheory of information and signal processing as well as on themodulation and demodulation are needed to follow this material.

Material content:

Chapter 1. Reminders on digital modulations (4 weeks)

- Narrowband and wideband modulations
- ASK, FSK, PSK type digital modulations
- Band-Limited Digital Transmissions
- Evaluations of digital transmission systems
- AWGN Receivers: Demodulator and Detector

Chapter 2. Non-ideal channels (3 weeks)

- Wireless Channels, Multipath, Noise, Interference, Invariant and Variant Channels, Rice and Rayleigh Fading

Chapter 3. Multiple Access Techniques (4 weeks)

- Time Division Multiple Access (TDMA)
- Frequency Division Multiple Access (FDMA)
- Code Division Multiple Access (CDMA)
- Orthogonal Frequency Division Multiplexing (OFDM)

Chapter 4. MIMO Systems (4 weeks)

- Transmit diversity, Space-time coding, Spatial multiplexing
- Joint demodulation, Multi-user MIMO

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. *G. Baudouin, "Digital Radiocommunications", Dunod, 2002.*
2. *JM Brossier, "Signal and digital communication: equalization and synchronization", Hermès Science, 97*
3. *P. Comon, "Digital communications - Courses and exercises for the use of engineering students", Harmattan editions, 2010.*
4. *A. Glavieux, M. Joindot, "Digital communications, introduction", Educational collection of telecommunications, Masson, 1996.*
5. *A. Glavieux, M. Joindot, "Introduction to digital communications", Collection: Sciences Sup, Dunod, 2007.*
6. *HP Hsu, "Analog and Digital Communications: Courses and Problems", McGraw-Hill, 1994.*
7. *G. Mahé, "Digital communication systems", Ellipses.*
8. *LW Couch, "Digital and Analog Communication Systems", Prentice-Hall, New-Jersey, 2007.*
9. *S. Haykin, "Communication Systems", John Wiley and Sons, Hoboken, New-Jersey, 2001.*
10. *J. Proakis, M. Salehi, "Communication Systems Engineering", 2nd edition, Prentice-Hall, New-Jersey, 2002.*
11. *B. Rimoldi, "Principles of Digital Communications", Ecole Polytechnique de Lausanne (EPFL), Switzerland.*
12. *J. Proakis, "Digital Communications", McGraw-Hill, 2000.*
13. *B. Sklar, "Digital Communications, Fundamentals and applications", Prentice Hall, 2001.*
14. *BP Lathi, "Modern Digital and Analog Communication Systems", Oxford University Press, 1998.*

Semester: 1
Course Unit: UEF 1.1.1Subject 2:
Random Signals and Stochastic Processes
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
The student receives the basic notions that allow him to understand and apply signal processing methods concerning random signals and stochastic processes.

Recommended prior knowledge:
Knowledge of deterministic signal processing and probabilities is required to follow this material.

Material content:

Chapter 1. Notions of correlation and convolution (3 weeks)
- Reminders on linear systems (Definition, properties, dynamic filters, etc.)
- Notion of correlation and convolution
- Application of the concept of correlation to physical quantities
- Fundamental application of correlation methods
  - Identification of processes and detection of signals drowned in noise
  - Spectral analysis (by filtering, Fourier transform, correlation, spectral densities)

Chapter 2. Notions of random variables (4 weeks)
- Physical notion of random phenomena
- Reminders on probabilities and statistics (probability density, distribution function, etc.)
- Continuous and discrete random variables
- Moments and conditional statistics
- Sequences of random variables- Functions of random variables- Covariance

Chapter 3. Random Signal Processing (4 weeks)
- Random signals (statistical and temporal representations)
- Stationarity and statistical properties (mean, variance, standard deviation, etc.)
- Power spectral density
- Sampling random signals
- Filtering Random Signals - Matched Filter, Wiener Filter
- Statistical estimation and spectral estimation
- Periodogram, correlogram, averaged periodogram, smoothed periodogram
- AR, MA and ARMA models

Chapter 4. Stochastic Processes (4 weeks)
- Notions of stochastic processes
- Stationarities in the broad and strict sense, ergodicity
- Stochastic input systems
- Examples of stochastic processes (Poisson, Gaussian and Markov processes)
- Higher order statistics (Moments and cumulants, Polyspectra, non-Gaussian processes, non-linear treatments)
- Introduction to particle filtering

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:

1. *S. Haykin, "Signals and systems", John Wiley & sons, 2ed, 2003.*
2. *AV Oppenheim, "Signals and systems", Prentice-Hall, 2004.*
3. *Mori Yvon, "Random signals and stochastic processes", Lavoisier, 2014*
4. *A. Papoulis, "Probability, Random variable and Stochastic Processes", Mc Graw Hill 1984.*
5. *E. Robine, "Introduction to the theory of communication, Volume II: Random signals", Masson 1970.*
6. *N. Hermann, "Engineering probabilities: random variables and Birch simulations", 2002.*
7. *Ruegg, Alan, "Stochastic process", Lausanne: Polytechnic and university press, 1989.*

Semester: 1
Course unit: UEF 1.1.2 Subject 3:
Radiocommunication
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Study of the behavior of radio waves at ground level and in the atmosphere (Troposphere, stratosphere and ionosphere). This matter will also be studied for satellite links.

Recommended prior knowledge:

Knowledge of electromagnetism is necessary to follow this subject. This knowledge is provided at the level of the subject "Waves and propagation" of the third year Telecommunications license.

Material content:

Chapter 1. Electromagnetic Field Theory (3 weeks)

- Reminders on Maxwell's equations (Origin and detailed demonstration)
- Propagation of the plane electromagnetic wave in vacuum (Wave equations, Electromagnetic Energy, Poynting vector)
- Propagation of an electromagnetic wave in dielectrics (Reflection, Refraction, Standing waves)
- Polarization of plane waves
- Propagation in an anisotropic medium

Chapter 2. Propagation of Hertzian Waves (3 weeks)

- Spectrum of Hertzian waves
- Propagation modes of Hertzian waves (Influence of the ground, troposphere, stratosphere, ionosphere)
- Atmospheric refraction (Electrical theory, Definition of a fictitious earth)
- Propagation in inhomogeneous and random media (Statistics of incoherent waves…)

Chapter 3. Ground Reflection (3 weeks)

- Reflection on the ground with and without obstacle
- Influence of ground irregularities
- Definition and criteria of a link in optical and radioelectric visibility

Chapter 4. Study of links in free space (3 weeks)

- Defining the Gain and Effective Area of an Antenna
- Attenuation in free space: FRIIS equation
- Telecommunications equation for a link with and without a passive relay
- Analog and digital links, Simplex links, Half-duplex
- Architecture and specifications of a radio system

Chapter 5. Space radiocommunication (3 weeks)

- Satellite-ground links and applications (Transmission and location, Earth stations, Artemis system between earth stations and satellites)
- Applications to some telecommunications services (fixed ground-ground links, fixed satellite service, communications with mobiles)

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. *P. Rosnet, "Elements of electromagnetic propagation: Fundamental physics", 2002.*
2. *G. Dubost, "Free and guided propagation of electromagnetic waves", Masson, 1995.*
3. *M. Jouquet, "Electromagnetic waves 1: free propagation", Dunod, 1973.*
4. *C. Garing, "Electromagnetic Waves in Dielectric Media: Exercises and Corrected Problems", 1998.*
5. *C. Garing, "Electromagnetic Waves in Vacuum and Conductive Media: Exercises and problemscorrected", 1998.*

Semester: 1
Course Unit: UEF 1.1.2 Subject 4:
Programmable circuits FPGA
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

In this subject, students will have to study the different types of programmable circuits, as well as the different design methods, in particular programming using hardware description languages.

Recommended prior knowledge:

Digital electronics (combinatorial and sequential)

Material content:

Chapter 1. Programmable Logic Networks: PLD **(3 weeks)**

- Introduction
- Structure of combinatorial logic networks
- Classification of combinatorial logic networks

Chapter 2. Programmable Element Technologies **(3 weeks)**

Chapter 3. Architecture of FPGAs **(3 weeks)**

- Presentation of CPs (PLA, CPLD type programmable circuits)
- Structure of FPGAs & ASICs
- General Architecture
- Programmable logic blocks
- Terminologies
- Built-in memory blocks
- Examples of Altera and Xilinx constructors
- Apps

Chapter 4. VHDL Programming **(3 weeks)**

- Introduction
- Programming tools: Altera Quartus II, Modelsim, Xilinx ISE
- Structure of a program
- Structure of a simple VHDL description
- Entity
- The different descriptions of an architecture (data flow type, behavioral or procedural, structural and test architecture)
- process
- Control structures in VHDL
- Sequential and concurrent instructions
- Packages and Libraries

Chapter 5. Applications: Implementation of some logic circuits in FPGA circuits

- Multiplexer **(3 weeks)**
- Counter
- Comparator
- shift register
- Simple filter

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. *Volnei A. Pedroni, "Circuit Design with VHDL", MIT press, 2004.*
2. *Jacques Weber, Sébastien Moutault, Maurice Meaudre, "VHDL language: from language to circuit, from circuit to language", DUNOD, 2007.*
3. *Christian Tavernier, "Programmable logic circuits", DUNOD 1992.*

Semester: 1
Course unit: EMU 1.1Subject 1:
TP Advanced digital communications
VHS : 22h30 (TP : 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

This material describes a simulation of a digital communication chain carried out with Matlab and Simulink software: modulation of digital signals at baseband and on the carrier frequency, transmission of signals - noisy and limited band transmission channel - reception and finally the implementation of new concepts of advanced communications.

Recommended prior knowledge:

Signal processing, programming in MATLAB.

Material content:

TP1: Blockset communication under simulink

- Signal Terminology: Frame or Sample
- Source and sink libraries
- simulation of digital communication chains by simulink

TP2: Study of the performance of digital modulation techniques

- Performance of a coherent digital communication system with BASK, BPSK and BFSK modulation
- Performance of a digital communication system inconsistent with BDPSK modulation
- Performance of a coherent digital communication system with QAM modulation

TP3: Simulation of an OFDM and CDMA transmission by simulink

- Theoretical reminder of OFDM and CDMA transmission
- Detailed study of the blocks of the OFDA simulated system
- Examples of multipath channels

Practical work 4: Simulation of a MIMO transmission chain Evaluation mode:

Continuous control: 100%

Bibliographic references:

1. *G. Baudouin, "Digital Radiocommunications", Dunod, 2002.*
2. *JM Brossier, "Signal and digital communication: equalization and synchronization", Hermès Science, 97*
3. *P. Comon, "Digital communications - Courses and exercises for the use of engineering students", Harmattan editions, 2010.*
4. *A. Glavieux, M. Joindot, "Digital communications, introduction", Educational collection of telecommunications, Masson, 1996.*
5. *A. Glavieux, M. Joindot, "Introduction to digital communications", Collection: Sciences Sup, Dunod, 2007.*
6. *HP Hsu, "Analog and Digital Communications: Courses and Problems", McGraw-Hill, 1994.*
7. *G. Mahé, "Digital communication systems", Ellipses.*
8. *LW Couch, "Digital and Analog Communication Systems", Prentice-Hall, New-Jersey, 2007.*
9. *S. Haykin, "Communication Systems", John Wiley and Sons, Hoboken, New-Jersey, 2001.*
10. *J. Proakis, M. Salehi, "Communication Systems Engineering", 2nd edition, Prentice-Hall, New-Jersey, 2002.*
11. *B. Rimoldi, "Principles of Digital Communications", Ecole Polytechnique de Lausanne (EPFL), Switzerland.*
12. *J. Proakis, "Digital Communications", McGraw-Hill, 2000.*
13. *B. Sklar, "Digital Communications, Fundamentals and applications", Prentice Hall, 2001.*
14. BP Lathi, "Modern Digital and Analog Communication Systems", Oxford University Press, 1998.

Semester: 1
Course unit: EMU 1.1Subject 2:
Practical work Random signals and stochastic processes
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Practical work carried out under MATLAB to give a practical aspect to complex theoretical notions.

Recommended prior knowledge:

Mathematics (Theory and calculation of probabilities, Complex analysis)- Deterministic signal theory, Probabilities and statistics.

Material content:

TP 1: Simulation of random variables (Different laws).
TP 2: Calculation of the power spectral density.
TP 3: Calculation of the auto-correlation and inter-correlation function.
PT 4: Filtering of random signals.
PT 5: Spectral analysis of random signals.

Assessment method:

Continuous control: 100%

Bibliographic references:

1. *S. Haykin, "Signals and systems", John Wiley & sons, 2ed, 2003.*
2. *AV Oppenheim, "Signals and systems", Prentice-Hall, 2004.*
3. *Mori Yvon, "Random signals and stochastic processes", Lavoisier, 2014*
4. *A. Papoulis, "Probability, Random variable and Stochastic Processes", Mc Graw Hill 1984.*
5. *E. Robine, "Introduction to the theory of communication, Volume II: Random signals", Masson 1970.*
6. *N. Hermann, "Engineering probabilities: random variables and Birch simulations", 2002.*
7. *Ruegg, Alan, "Stochastic Process", Lausanne: Polytechnic and University Presses Romandes, 1989*.

Semester: 1
Course unit: EMU 1.1 Subject 3:
TP Programmable circuits FPGA
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

This material allows the student to design an electronic system using the VHDL description language and test each design on the FPGA.

Recommended prior knowledge:

Digital electronics

Material content:

TP1: Introduction to the VHDL language. Presentation of the development tool: development board and simulation software.
TP2: Exploitation of the VHDL simulator.
Practical work 3: Development of a first circuit example: decimal counter.
Practical work 4: Development of a second circuit example: multiplexer.
Practical work 5: Development of a third circuit example: shift register. TP6:
Implementation of an FPGA.

Assessment method:

Continuous control: 100%

Bibliographic references:

1. *Volnei A. Pedroni, "Circuit Design with VHDL", MIT press, 2004.*
2. *Jacques Weber, Sébastien Moutault, Maurice Meaudre, "VHDL language: from language to circuit, from circuit to language", DUNOD, 2007.*
3. *Christian Tavernier, "Programmable logic circuits", DUNOD 1992.*

Semester: 1
Course unit: EMU 1.1Subject 4:
Object-oriented programming in C++
VHS: 37h30 (Course: 1h30, TP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

The student will have to learn from this material the basic foundations of object-oriented programming as well as the mastery of techniques for designing advanced programs in the C++ language.

Recommended prior knowledge:

Programming in C language.

Material content:

Chapter 1. Introduction to object-oriented programming (OOP) (2 weeks) Principle of OOP, Definition of the C++ language, Getting started with the C++ language, The C core of the C++ language.

Chapter 2. Basics (2 weeks)

Control structures, Functions, Arrays, Recursion, Files, Pointers, Pointers and references, Pointers and arrays, Dynamic allocation.

Chapter 3. Classes and Objects (3 weeks)

Class declaration, Variables and instance methods, Definition of methods, Access rights and encapsulation, Prototype separations and definitions, Constructor and destructor, Constant methods, Association of classes with each other, Classes and pointers.

Chapter 4. Inheritance and Polymorphism (3 weeks)

Inheritance, Rules of inheritance, Chaining of constructors, Base classes, Preprocessor and compilation directives, Polymorphism, Rules to follow, Methods and abstract classes, Interfaces, Uniform processing, Dynamic arrays, Chaining of methods, Implementation of virtual methods, Classes nested.

Chapter 5. Containers, iterators and functors (3 weeks)

Sequences and their adapters, Associative tables, Choosing the right container, Iterators: boosted pointers, The full power of lists and maps, Function: the object version of functions, Merging the two concepts.

Chapter 6. Advanced concepts (2 weeks)

Exception handling, Standard exceptions, Assertions, Template functions, Specialization, Template classes.

TP Object-oriented programming in C++

- TP1: Mastery of a C++ compiler
- Practical work 2: C++ programming
- TP3: Classes and objects
- TP4: Inheritance and polymorphism
- TP5: Memory management
- TP6: Templates

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. Bjarne Stroustrup (C++ Author), The C++ Language, Pearson.

2. Claude Delannoy, Programming in C++ language, 2000.

3. Bjarne Stroustrup, Le Langage C++, Édition Addison -W l (2000) Wesley (2000) or Pearson Education France (2007).

4. PN Lapointe, Bridge between C and C++ (2nd Edition), Vuibert, Edition 2001.

Semester: 1
Course unit: UED 1.1 Subject:
Subject of your choice
VHS : 22h30 (course :1h30)
Credits: 1
Coefficient: 1

Semester: 1
Course unit: UED 1.1 Subject:
Subject of your choice
VHS : 22h30 (course :1h30)
Credits: 1
Coefficient: 1

Semester: 1
Course unit: UET 1.1 Subject: UET 1.1
Technical English and terminology
VHS: 22h30 (course : 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

To introduce the student to technical vocabulary. Strengthen your knowledge of the language. Help him understand and synthesize a technical document. Enable him to understand a conversation in English held in a scientific setting.

Recommended prior knowledge:

Vocabulary and basic grammar in English

Material content:

- Written comprehension: Reading and analysis of texts relating to the specialty.

- Listening comprehension: From authentic video documents of popular science, note taking, summary and presentation of the document.

- Oral expression: Presentation of a scientific or technical subject, elaboration and exchange of oral messages (ideas and data), Telephone communication, Gestural expression.

- Written expression: Extraction of ideas from a scientific document, Writing of a scientific message, Exchange of information in writing, writing CVs, letters requesting internships or jobs.

Recommendation :It is strongly recommended that the person in charge of the subject present and explain at the end of each session (at most) about ten technical words of the specialty in the three languages (if possible): English, French and Arabic.

Assessment mode:

Review: 100%.

Bibliographic references:

1. *PT Danison, Practical guide to writing in English: customs and rules, practical advice, Editions d'Organisation 2007.*
2. *A. Chamberlain, R. Steele, Practical guide to communication: English, Didier 1992.*
3. *R. Ernst, Dictionary of techniques and applied sciences: French-English, Dunod 2002.*
4. *J. Comfort, S. Hick, and A. Savage, Basic Technical English, Oxford University Press, 1980.*
5. *EH Glendinning and N. Glendinning, Oxford English for Electrical and Mechanical Engineering, Oxford University Press 1995.*
6. *TN Huckin, and AL Olsen, Technical writing and professional communication for non-native speakers of English, Mc Graw-Hill 1991.*
7. *J. Orasanu, Reading Comprehension from Research to Practice, Erlbaum Associates 1986.*

Proposal of some discovery materials (S1)

Semester: 1
Course unit: UED 1.1 Subject 1:
Standards and Protocols
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Introduce the student to the most common communication protocols. Teach the student how to specify protocols and standards. Ddistinguish the networks and protocols related to each layer (level) of the OSI and TCP/IP models, acquire a good knowledge of the concepts related to the different types of networks and protocols.

Recommended prior knowledge:

Information theory, elements of a network.

Material content:

Chapter 1. Fundamentals (2 weeks)
Telecommunication standardization institutions (ITU, IEC, OSI, IEEE, etc.). History and evolution. Standards, recommendations, norms and protocols (definitions and differences). Role of a protocol.
Chapter 2. Standards associated with analogue and digital broadcasting (2 weeks)
Analog audio and video standards (CCIR and NTSC, etc.), Digital audio and video standards (DVB, ATSC, ISDB, NICAM, etc.).
Chapter 3. Standards associated with digital communication networks (4 weeks)
Classifications of communication networks. Networks and standardization. History and evolution of networks. Integrated services digital network, Reminders on the OSI and TCP/IP models. The different frame and packet level protocols. The different segment and message level protocols. ADSL protocols.
Chapter 4. Wireless and mobile network protocols (4 weeks)802.11 protocols. 802.15 protocols. 802.16 protocols. GSM protocols. 3G (UMTS) protocols. 4G (LTE) protocols.
Chapter 5. Internet Protocols (3 weeks)
Internet (History and evolution). Classification of Internet protocols. Email service protocols (SMTP, POP, IMAP). Information services protocols (http, ftp, application protocols).

Assessment method:

Review: 100%.

Bibliographic references:

1. *Michel Kadoch, "Protocols and local networks", Presses de l'université du Québec, 2012.*
2. *José Dordoigne," Local and extended networks: fundamental notions", Editions ENI, 2005.*
3. *Guy Pujolle," Networks", Eyrolles, 2008.*
4. *Claude Rigault, "IP-based telecom networks and their interconnections", Hermes-Lavoisier, 2015.*

Semester: 1
Course unit: UED 1.1 Subject 2:
Electromagnetic compatibility
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This subject will allow students to discover low frequency and high frequency disturbances, as well as the mechanisms in electronic circuits (EMC). The theoretical foundations on electromagnetic compatibility (EMC) with descriptions of the main electromagnetic interactions are described.

Recommended prior knowledge:

The basics of electrostatics and electromagnetism.

Material content:

Chapter 1. Electrostatic and magnetostatic phenomena (3 weeks)

Origin of electrostatic and magnetostatic phenomena, Problems of ECM disturbances in LF and HF, Electrostatic field lines, Characteristics of the electrostatic and electromagnetic field, Application in the case of electromagnetic compatibility.

Chapter 2. Calculation method of electromagnetic interactions (3 weeks)

Notion of graph of the representation by Kron's Method, Matrix of impedances, Vector of sources and Connectivity, Resolution of the system of equations, General principle of guided waves, Potential and vector of Poynting.

Chapter 3. Penetration of Cable Shields (3 weeks)

Treatment of shielded boxes, Sources of noise in electronic circuits, Evolution of technologies, Consequences on EMC, EMC modeling and components, Radiation E, H. Chapter 4. Investigation techniques in EMC **(3 weeks)**

Immunity tests to electrostatic and magnetic discharges, Immunity tests to conducted disturbances, Immunity tests to radiated disturbances.

Chapter 5. EMC Protection Techniques (3 weeks)

Protection of components and shields, Filtering, Protection against overvoltages.

Assessment method:

Review: 100%.

Bibliographic references:

1. *D. Cheng ''Field and Wave Electromagnetics, Pearson Education, New York, 2006.*
2. *D. Pozar 'Microwave engineering, Addison Wesley publishing Company New York, 1995.*
3. *M. Mardiguian, "Practical manual of electromagnetic compatibility", Lavoisier.*

II - Detailed program by subject of semester S2

Semester: 2
Course Unit: UEF 1.2.1 Subject 1:
Digital signal processing
VHS: 67h30 (Course: 3h00, TD: 1h30)
Credits: 6
Rating: 3

Teaching objectives:
This subject covers the fundamental bases relating to digital signal processing. It essentially discusses the various digital signal filtering techniques and some of their applications.

Prior knowledge recommended :
Mathematics, signal theory and signal processing.

Content of the subject :

Chapter 1.Discrete Fourier Transform (2 weeks)
- Reminders on sampling and quantization operations
- The TFTD (Discrete Time Fourier Transform)
- Definition and properties of DFT (Discrete Fourier Transform)
- Fast Fourier Transform (FFT)

Chapter 2.Digital filters (3 weeks)
- Linear and invariant discrete systems
- Definition and properties
- Discrete convolution
- Finite Difference Equation
- Z Transformation - Properties and Convergence Conditions
- Structures, transfer functions in z, notions of poles and zeros, stability and implementation of digital filters (RIF and RII)
- RIF vs. RII

Chapter 3. Synthesis of FIR digital filters (2 weeks)
- Linear phase FIR filters (all four cases)
- Synthesis by window method
- Synthesis by the frequency sampling method
- Iterative synthesis and Remez's algorithm
- Comparison

Chapter 4. Synthesis of digital IIR filters (3 weeks)
- Reminders on Butterworth, Bessel, Chebychev I and II, Elliptical type analog filters. Frequency normalization and denormalization.
- RII synthesis by methods of transformations in particular bilinear
- Effects of quantization noises
- Examples of IIR filter structures
- Digital underphase filter (filter and its inverse are stable)
- Advantages and disadvantages

Chapter 5. Multirate Digital Filters (2 weeks)
- Undersampling and oversampling
- Multirate systems and spectral analysis
- Filter bank and polyphase decomposition
- Multirate processing applications

Chapter 6. Discrete Wavelet Transform (DWT) (3 weeks)
- Time-frequency duality and short-term Fourier transform. Disadvantages.
- Continuous, discrete (DWT) wavelets and dyadic wavelets
- Examples of DWT (Haar, Daubechies, ...etc)
- Multi-resolution analysis
- Facelift version of the DWT
- Application examples

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:

1. M. Kunt, ''Digital Signal Processing'', Dunod, Paris, 1981.
2. J. M Brossier, ''Signal and Digital Communications'', Signal Processing Collection, Hermès, Paris, 1997.
3. G. Blanchet and M. Charbit, ''Signals and Images under Matlab: Methods, Applications and Corrected Exercises'', Hermès, Paris, 2001.
4. M. Bellanger, ''Digital signal processing: Theory and practice'', 8th edition, Dunod, 2006.
5. Messaoud Benidir, ''Basic methods for signal analysis and processing'', Dunod 2004.
6. Yvon Mori, ''Digital filtering''. Flight. IV, Hermes-Lavoisier. 2006
7. Yvon Mori, ''Digital filtering in signal processing - Exercises and practical work''. Hermès-Lavoisier.

Semester: 2
Course Unit: UEF 1.2.1 Subject 2:
Antennas
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
This subject aims at the detailed calculation of the radiation of the electric doublet and the antennas. In this subject, uniform and non-uniform antenna arrays as well as antenna curtains, radiating apertures (rectangular and circular) and planar antennas are also studied.

Prior knowledge recommended :
Knowledge of electromagnetic radiation is necessary to track this material. This knowledge is provided at the level of the subject "Antennas and transmission lines" of the third year Telecommunications license.

Content of the subject :

Chapter 1. General and characteristic parameters of antennas (3 weeks)
- Reminders on the characteristic parameters of an antenna (Planes E and H, tuning wavelength, polarization, radiation patterns, effective height, radiated power, radiation resistance, antenna impedance, gain, directivity, received power , effective area).
- Concept of vector potential and scalar potential.
- Radiation of the electric doublet (calculation of the electromagnetic field in the far zone, characteristic surface, radiated power, equivalent height, radiation resistance, radiation digraph).

Chapter 2. Wire Antennas (3 weeks)
- Rectilinear antenna isolated in space (Characteristic function, radiation pattern).
- Antenna fed in the middle.
- Antenna vertical above the ground.
- Traveling wave wire antennas (Horizontal antenna, V antenna, Diamond antenna).

Chapter 3. Antenna Arrays (3 weeks)
- Antenna arrays, Type of antenna arrays (longitudinal and transverse radiation).
- Uniform network.
- Non-uniform network (Dolph-Tchebychev weighting).
- Other antenna array synthesis methods (Shelkunof method, Fourier transform method, etc.).
- Antenna curtain.

Chapter 4. Radiation from plane openings (3 weeks)
- General study of the radiation of an opening (Principle of Huygens – Fresnel, relations of Green and Kottler).
- Radiation from a rectangular opening.
- Radiation from a circular aperture.

Chapter 5. Planar antennas (3 weeks)
- Patch antennas, application of Wheeler's relations, patch antenna arrays, adaptation and radiation of planar antennas.

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:
1. F. Gardiol, "Electromagnetism: Treaty of electricity", Edition Lausanne.
2. P. Combes, "Mico-waves, passive circuits, propagation, antennas, Courses and exercises", Dunod, 1997.
2. R.-C. Houzé, "Antennas, Fundamentals", Dunod, 2006.
3. A. Ducros, "Antennas: Theory and practice", Emission and reception, Elektor, 2008.
4. WL Stutzman, GA Thiele, "Antenna Theory and Design", John Wiley.
5. C. Balanis, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley & Sons Inc, 2005.
6. R. Aksas, "Telecommunications: Antennas Theory and Applications", Ellipses Marketing, 2013.
7. O. Picon et al, "Antennas: Theory, design and applications", Dunod, 2009.

Semester: 2
Teaching unit: UEF 1.2.2 Subject 3:
Transmission channels
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
This material aims at the principle of wave propagation in transmission lines and waveguides as well as their adaptations.

Prior knowledge recommended :
Knowledge of electromagnetic radiation is necessary to track this material. This knowledge is provided at the level of the subjects "Transmission media" and "Antennas and transmission lines" of the third year Telecommunications license.

Content of the subject :

Chapter 1. Introduction to transmission lines (4 weeks)

- Fundamental equation of a line in sinusoidal mode (diagram of a line, equations of a line, impedance of the line, equations of the telegraphers).
- Traveling Waves, Standing Waves, Group Velocity, Phase Velocity, Reflection Coefficient, TOS-VSWR Standing Wave Ratio.
- Power transmission.
- Transient phenomena on transmission lines (study in impulse regime, study in voltage step regime, superposition diagrams, applications: Matched and unmatched generator - with resistive load, capacitive load, inductive load).

Chapter 2. Impedance matching in transmission lines (4 weeks)

- Matching by impedance transformer under a line stub, by quarter-wave line, using reactive LC circuits, using a stub, two stubs, three stubs, broadband matching, etc.
- Smith's abacus (foundations, construction and description of the abacus).
- Determination of the reflection coefficient, of the standing wave ratio and resolution of impedance matching problems in a line using the Smith chart.
- Use of the abacus in admittance.

Chapter 3. Waveguides (4 weeks)

- Rectangular waveguides: TM and TE modes, dispersion equation, Propagation constant, cut-off frequency, Impedance,…
- Rectangular electromagnetic cavities.
- Cylindrical waveguides: TM and TE modes, dispersion equation, propagation constant, cut-off frequency, impedance,…
- Cylindrical electromagnetic cavities.

Chapter 4. Other Line Types and Planar Structures (3 weeks)

- Wired lines (two-wire line, coaxial, twisted).
- Planar strip lines (Micro strip line, strip line, suspended substrate line) and slot lines (slot line, coplanar line, fin line).

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographic references:

1. F. Gardiol, "Electromagnetism: Treatise on electricity", Edition Lausanne.
2. P. Combes, "Mico-waves, passive circuits, propagation, antennas, Courses and exercises", Dunod, 1997.
3. G. DUBOST, "Free and guided propagation of electromagnetic waves / Radiation -Exercises with solutions and course reminders".
4. J. Quinet, "Theory and practice of electronic circuits and amplifiers, Propagation of HF current along lines; Abacus of Smith- Antenna. Maxwell's Equations and Applications".

Semester: 2
Teaching unit: UEF 1.2.2 Subject 4:
Coding and Compression
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Familiarize the student with data coding and compression techniques such as channel coding, source coding and image compression. The student will have to learn from this material the basic foundations for the evaluation of the advantages and disadvantages of the different compression techniques as well as the criteria for choosing a data compression technique. Recommended prior knowledge: Probability and statistics, information theory, signal processing.

Content of the subject :

Chapter 1. Fundamentals of source coding and channel coding (2 weeks)

- Definition, difference and interest of channel coding and source coding
- Source and source coding
- Channel and channel coding
- Notions on joint coding

Chapter 2. Entropy codings (2 weeks)

- Reminders on information theory.
- Entropy and measurement of information
- Huffman coding – the adaptive versions of Huffman and Shannon-Fano
- Arithmetic coding
- LZW coding
- Evaluation criteria

Chapter 3: Channel Coding (4 weeks)

- Main concepts and definitions
- General communication scheme and transmission channel
- Type of channels
- Efficiency, Redundancy and Channel Capacity
- Channel coding and Shannon's second theorem. Channel Coding Strategies
- Error correction coding (Hamming codes, linear codes, cyclic codes, Reed-Solomon codes, etc.)
- Turbo-codes and LDPC code
- Performance of an encoder
- Application examples

Chapter 4. Lossy Compression Methods (3 weeks)

- General notions and definition.
- General scheme of compression methods based on transformations
- Evaluation criteria (MSE, PSNR, CR, SSIM ..etc)
- Description of the different parts (Transformation, Quantification and entropy coding)
- Effects of transformation on compression method
- Effects of quantization and different types of quantization
- Image compression standards and bodies

Chapter 5. Image Compression Techniques (Case of JPEG) (4 weeks)

- The JPEG standard, principle and history
- DCT and its different versions. Properties and advantages.
- Cutting into 8x8 blocks and DCT2D
- Quantization matrix
- Zig-zag sweep
- Entropy coding
- Calculations of MSE, PSNR, CR, SSIM and computational complexity
- General information on image compression methods based on DWT (Examples: EZW or SPIHT or JPEG2000, etc.), comparison with JPEG.

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. *M. Cover and JA Thomas, "Elements of information theory", 2nd edition, Wiley Series in telecommunications and signal Processing, 2006.*
2. *M. Barlaud, C. Labit, "Compression and coding of images and videos", treatise Collection IC2, Ed. Hermés, 319p, 2002.*
3. *K. Sayood, "Introduction to Data Compression, Third Edition", Elsevier Inc. 2006.*
4. *Olivier Rioul, "Theory of information and coding", Edit. Lavoisier, 2007.*
5. *N. Moreau, "Tools for signal compression: applications to audio signals", Collection*
6. *Telecom, Edition Lavoisier, October 2009.*
7. *JC, Moreira, PG, Farrell, "Essentials of Error-Control Coding", John Wiley and Sons, Ltd, 2006.*
8. *C. Berrou, "Codes and turbocodes", Springer-verlag France, 2007.*

Semester: 2
Course unit: UEM 1.2 Subject 1:
TP Digital signal processing
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
At the end of this subject, the student will be able to manipulate digital signals by implementation, programming and analysis. Teach the student the usual digital processing such as digital filtering and data denoising.

Prior knowledge recommended :
Mathematics, signal theory and signal processing.

Content of the subject :

TP1: Comparison between TFD and FFT (calculation time depending on the number of points, restitution errors, etc.)

Practical work 2: Analysis, Synthesis (windows method) and implementation of an RIF digital filter

Practical work 3: Analysis, Synthesis by bilinear transformation (case of Butterworth and Tchebychev filters) and implementation of an RII digital filter

TP4: Application of digital filtering on an audio signal

TP5: Implementation of a bank of digital filters (application to a speech signal) TP6:

Denoising of a signal by discrete wavelet transform

Assessment method:
Continuous control: 100%

Bibliographic references:
1. M. Kunt, ''Digital Signal Processing'', Dunod, Paris, 1981.
2. J. M Brossier, ''Signal and Digital Communications'', Signal Processing Collection, Hermès, Paris, 1997.
3. G. Blanchet and M. Charbit, ''Signals and Images under Matlab: Methods, Applications and Corrected Exercises'', Hermès, Paris, 2001.
4. M. Bellanger, ''Digital signal processing: Theory and practice'', 8th edition, Dunod, 2006.
5. Messaoud Benidir, ''Basic methods for signal analysis and processing'', Dunod 2004.
6. Yvon Mori, ''Digital filtering''. Flight. IV, Hermes-Lavoisier. 2006
7. Yvon Mori, ''Digital filtering in signal processing - Exercises and practical work''. Hermès-Lavoisier.

Semester: 2
Course unit: UEM 1.2 Subject 2:
TP Antennas and transmission channels
VHS: 22h30 (TP : 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
In this subject, the student will learn to use software dedicated to microwaves for the simulation of radiating structures. As for the practical side, it will be devoted to antenna measurements and guided propagation (transmission channels).

Prior knowledge recommended :
Knowledge of electromagnetic radiation is necessary to track this material. This knowledge is provided at the level of the subjects "Transmission media" and "Antennas and transmission lines" of the third year Telecommunications license.

Content of the subject :

Exercise 1: Simulation of different antenna structures using microwave CAD software (CST, Momentum, HFSS ...).

TP 2: Antenna measurement (Cornet - Helicoidal antenna - Slotted antenna - Parabolic antenna)

Exercise 3: Calculation of the secondary parameters of a transmission line (case of the coaxial cable).

PT 4: Lines in pulse mode.

Exercise 5: Measurement on a waveguide transmission chain.

- Measurement of guided wavelength, reflection coefficient and SWR
- Measurement of an unknown impedance
- Measurement and evaluation of the dielectric constant

Assessment method:
Continuous control: 100%

Bibliographic references:
1. F. Gardiol, "Electromagnetism: Treaty of electricity", Edition Lausanne.
2. P. Combes, "Mico-waves, passive circuits, propagation, antennas, Courses and exercises", Dunod, 1997.
2. R.-C. Houzé, "Antennas, Fundamentals", Dunod, 2006.
3. A. Ducros, "Antennas: Theory and practice", Emission and reception, Elektor, 2008.
4. WL Stutzman, GA Thiele, "Antenna Theory and Design", John Wiley.
5. C. Balanis, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley & Sons Inc, 2005.
6. R. Aksas, "Telecommunications: Antennas Theory and Applications", Ellipses Marketing, 2013.
7. O. Picon et al, "Antennas: Theory, design and applications", Dunod, 2009.
8. G. Dubost, "Free and guided propagation of electromagnetic waves / Radiation -Exercises with solutions and course reminders".
9. J. Quinet, "Theory and practice of electronic circuits and amplifiers, Propagation of HF current along lines; Abacus of Smith- Antenna. Maxwell's Equations and Applications".

Semester: 2
Course unit: UEM 1.2 Subject 3:
TP Coding and compression
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Familiarize the student with data coding and compression techniques such as channel coding, source coding and image compression.

Recommended prior knowledge:
Probability and statistics, information theory, signal processing.

Content of the subject :

TP1: Study and simulation of Huffman Coding.

TP2: Study and simulation of Shannon Fano's Coding.

TP3: Modeling of a chain with source coding and channel coding on a binary then Gaussian channel

TP4: Example of implementation of fast DCT with low arithmetic complexity

TP5: Implementation under matlab of the JPEG image compression method

TP6: Implementation under matlab of an image compression method based on DWT (example EZW or Spiht ... etc)

Assessment method:
Continuous control: 100%

Bibliographic references:

1. *M. Cover and JA Thomas, "Elements of information theory", 2nd edition, Wiley Series in telecommunications and signal Processing, 2006.*
2. *M. Barlaud, C. Labit, "Compression and coding of images and videos", treatise Collection IC2, Ed. Hermés, 319p, 2002.*
3. *K. Sayood, "Introduction to Data Compression, Third Edition", Elsevier Inc. 2006.*
4. *Olivier Rioul, "Theory of information and coding", Edit. Lavoisier, 2007.*
5. *N. Moreau, "Tools for signal compression: applications to audio signals", Collection*
6. *Telecom, Edition Lavoisier, October 2009.*
7. *JC, Moreira, PG, Farrell, "Essentials of Error-Control Coding", John Wiley and Sons, Ltd, 2006.*
8. *C. Berrou, "Codes and turbocodes", Springer-verlag France, 2007.*

Semester: 2
Course unit: UEM 1.2 Subject 4:
Image processing
VHS: 37h30 (Course: 1h30, Lab: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

Understand the concepts of image capture and digitization. Know the different parameters and formats of digital images. Master the basics of image analysis. Learn to use the preliminary tools in low-level digital image processing with an introduction to high-level processing.

Recommended prior knowledge:

Signal processing.

Content of the subject :

Chapter 1. Perception of color (2 weeks)

- Colorimetry. Light and color in human perception
- Color representation systems: RGB, XYZ, YUV, HSV, YIQ
- Color formats and color image processing strategies

Chapter 2. Image sensors and digital acquisition devices (2 weeks)

- Block diagram of an image processing chain.
- Principle of CCD and CMOS sensors
- Color Sensor Specifications
- Scanning an image
- Concepts of definition, resolution and quantification of a digital image (size, dpi, ppi, bpp ...etc)
- Examples of digital image formats (BMP, TIFF, JPG, GIF and PNG)

Chapter 3. Basic image processing (3 weeks)

- Histogram and contrast concept
- Correction of image dynamics by affine transformations on the histogram
- Histogram equalization and gamma correction
- Logical and arithmetic operations on images

Chapter 4. Digital Image Filtering (2 weeks)

- Spatial filtering and 2D Convolution: notion of mask (average, Gaussian, binomial, etc.)
- Linear then non-linear smoothing of the image (median, etc.)
- Frequency filtering: (2D FFT and separability property, low-pass filter, high-pass, etc.)

Chapter 5. Edge detection (3 weeks)

- Objectives and generalities
- Outline types
- 1st derivatives: convolution mask (Gradient operators: Roberts, Prewitt, Sobel mask, etc.)
- 2nd derivatives of an image (Laplacian operators, Marr-Hildreth filter)
- Laplacian operators vs Gradient operator (sensitivity to noise, localization, etc.)
- Optimal filter (optimality criteria, Canny and Derriche, etc.)

Chapter 6. Segmentation and Classification (3 weeks)

- Principle and different segmentation approaches (by thresholding, by regions, classification approach, etc.)
- Image thresholding: global thresholding, local thresholding, valley detection thresholding, dynamic thresholding, variance minimization thresholding, Bayesian classification methods, etc.
- Morphological operations (dilation, erosion, opening, closing, etc.)
- Extraction of parameters and classification of objects (Euclidean distance, Kppv, etc.)

Practical work Image processing

TP1: Matlab Toolbox for image and video processing
- Representation of digital images in matlab
- Color and palette treatments
- Image and video sequences (multi frame array)

Practical work 2: Digital image processing by MATLAB
- Getting started with images: reading, writing, display
- Point transformations on the image
- Processing on the histogram
- Transformation s Geometric on the image

TP3: Frequency processing of images in matlab
- FFT2D and linear filtering
- Noise models: image denoising
- Generation of filters from spatial filters or directly in the spectral domain TP4: Edge detection and segmentation

TP5: Binarization of images and morphological operations

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. Stéphane Bres, Jean-Michel Jolion, Frank Lebourgeois, ''Processing and analysis of digital images''. Hermès-Lavoisier. 2003.
2. Richard Berry, James Burnell, ''The Handbook of astronomical Image processing''. 2nd Edition. 2006.
3. Rafael C. Gonzalez & Richard E Woods, "Digital Image Processing", Prentice Hall, 2008.
4. Radu Horaud and Olivier, ''Computer vision''. Editions Hermès, 1995 – 2nd edition.
5. JP Cocquerez and Sylvie Philipp,''Image analysis: Filtering and segmentation''. Elsevier-Masson.
6. Diane Lingrand , ''Introduction to image processing''. Vuibert 2008.
7. Gilles Burel, "Introduction*to image processing. Simulation under Matlab''. Hermès-Lavoisier. 2001.*

Semester: 2
Course unit: UED 1.2 Subject:
Subject 1 of your choice VHS:
10:30 p.m. (lesson: 1:30 a.m.)
Credits: 1
Coefficient: 1

Semester: 2
Course unit: UED 1.2 Subject:
Subject 2 of your choice VHS:
10:30 p.m. (lesson: 1:30 a.m.)
Credits: 1
Coefficient: 1

Semester: 2
Course unit: UET 1.2 Subject:
Ethics, deontology and intellectual property
VHS : 22h30 (Cours : 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Develop student awareness of ethical principles. Introduce them to the rules that govern life at the university (their rights and obligations vis-à-vis the university community) and in the world of work. Make them aware of the respect and valuation of intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them.

Recommended prior knowledge:

None

Material content:

A- Ethics and deontology

I. Notions of Ethics and Deontology (3 weeks)

1. Introduction
   1. Definitions: Morality, ethics, deontology
   2. Distinction between ethics and deontology
2. Charter of ethics and deontology of the MESRS: Integrity and honesty. Academic freedom. Mutual respect. Requirement of scientific truth, objectivity and critical thinking. Equity. Rights and obligations of the student, teacher, administrative and technical staff.
3. Ethics and deontology in the world of work
   Legal confidentiality in business. Loyalty to the company. Responsibility within the company, Conflicts of interest. Integrity (corruption in work, its forms, its consequences, methods of fighting and sanctions against corruption)

II. Integral and responsible research (3 weeks)

1. Respect for the principles of ethics in teaching and research
2. Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
3. Adopting responsible conduct and combating excesses: Adopting responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

B- Intellectual property

I- Fundamentals of intellectual property (1 week)

1- Industrial property. Literary and artistic property.
2- Rules for citing references (books, scientific articles, conference papers, theses, dissertations, etc.)

II- Copyright (5 weeks)

1. Copyright in the digital environment

Introduction. Database copyright, software copyright. Specific case of free software.

2. Copyright in the internet and e-commerce

Domain name rights. Intellectual property on the internet. Law of the e-commerce site. Intellectual property and social networks.

3. Patent

Definition. Rights in a patent. Usefulness of a patent. Patentability. Patent application in Algeria and worldwide.

4. Trademarks, designs and models

Definition. Trademark Law. Design law. Denomination of origin. The secret. Counterfeit.

5. Geographical Indications Law

Definitions. Protection of Geographical Indications in Algeria. International Treaties on Geographical Indications.

III- Protection and enhancement of intellectual property (3 weeks)

How to protect intellectual property. Violation of rights and legal tool. Valuation of intellectual property. Protection of intellectual property in Algeria.

Assessment method:

Review: 100%

Referencesbibliographic:

1. Charter of Ethics and University Deontology, https://www.mesrs.dz/documents/12221/26200/Charte+fran_ais+d f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism
3. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
4. E. Prairat, On teacher ethics. Paris, PUF, 2009.
5. Racine L., Legault GA, Bégin, L., Ethics and Engineering, Montreal, McGraw Hill, 1991.
6. Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., Ethics, what will change in the company, editions of Organization, 2003.
8. Didier Ch., Thinking the ethics of engineers, Presses Universitaires de France, 2008.

9. Gavarini L. and Ottavi D., Editorial. of professional ethics in training and research, Research and training, 52 | 2006, 5-11.
10. Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.
11. Jacquet-Francillon, Francois. Concept: professional ethics. Le Télémaque, May 2000, n° 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, JC, Industrial Property Law. Dalloz 2003.
14. Wagret F. and JM., Patents, trademarks and industrial property. PUF 2001
15. Dekermadec, Y., Innovating through patents: a revolution with the internet. 1999
16. AEUTBM. The engineer at the heart of innovation. Belfort-Montbeliard University of Technology
17. Fanny Rinck and Léda Mansour, literacy in the digital age: copy-paste among students, Université Grenoble 3 and Université Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Citing your sources, IAE Nantes 2008
19. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on electronic plagiarism presented to the CREPUQ Sub-Committee on Pedagogy and ICT
20. Emanuela Chiriac, Monique Filiatrault and André Régimbald, Student Guide: Intellectual Integrity Plagiarism, Cheating and Fraud… Avoiding Them and, Above All, How to Cite Sources Properly, 2014.
21. Publication of the University of Montreal, Plagiarism prevention strategies, Integrity, fraud and plagiarism, 2010.
22. Pierrick Malissard, Intellectual property: origin and evolution, 2010.
23. The website of the World Intellectual Property Organizationwww.wipo.int
24. http://www.app.asso.fr/

Proposal of some discovery materials (S2)

Semester: 2
Course unit: UED 1.2 Subject 1:
Embedded Systems and Telecommunications
VHS : 22h30 (Cours : 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This subject aims for basic knowledge in a field that brings together two autonomous systems: an electronic and computer system called an embedded system. It will also allow students to know the different design stages of an embedded system.

Recommended prior knowledge:

Microprocessor.

Material content:

Chapter 1. Introduction to embedded systems (3 weeks)
- Features
- Historical
- Specificities of an embedded system
- Hardware and software aspects
- Functional description and architecture of embedded systems
- Embedded System Examples

Chapter 2. Embedded systems and real time (4 weeks)
- Introduction
- Memory management
- Competition management
- Linux for the embedded
- Presentation of embedded real-time systems
- Structure and operation of embedded real-time systems

Chapter 3. Architecture embedded processors (4 weeks)
- Main architectural concepts
- Operating systems for embedded systems
- Special purpose processors and general purpose processors
- Pipeline operation
- Memory hierarchy
- Peripherals and Interfaces
- Communication mechanisms and associated protocols
- Example Architecture

Chapter 4. Embedded Systems Design Methodology (3 weeks)
- Design environments
- Life cycle and development stages of an embedded system
- Control and regulation systems
- Design Examples

Chapter 5. Embedded Systems Security (1 Week)
- Hardware and software vulnerabilities
- Communications Security

Assessment method:

Review: 100%.

Bibliographic references:

1. K. Yaghmour, "Building Embedded Linux systems", O'Reilly Media, 2003.
2. Pierre Ficheux, "Embedded Linux", Eyrolles . 3rd Edit. 2010.
*3. R. Zurawski, "Embedded systems handbook",*Taylor & Francis Group, LLC. 2006
4. D. Paret, "Multiplexed networks for embedded systems", Dunod, 2012.

Semester: 2
Course unit: UED 1.2 Subject 2:
Technial Radar
VHS : 22h30 (Cours : 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective of this subject is to provide students with advanced notions on: the theory of decision and detection, Information processing. These notions will allow students to master the detection techniques relating to the different Radar types, but also to be able to understand the problems of future remote sensing equipment.

Recommended prior knowledge:

Signal processing.

Material content:

Chapter 1. Reminder on random processes **(2 weeks)**
- Continuous Time Random Processes, Discrete Time Random Processes
- Statistical measures
- Stationarity in the broad sense
- Gaussian process
- Power spectral density
- Statistical signals

Chapter 2. Statistical Decision Theory **(3 weeks)**
- Bayes criterion
- Binary hypothesis tests
- Minimax criterion, Neyman-Pearson criterion
- Sequential detection

Chapter 3. Estimation Methods **(3 weeks)**
- Likelihood estimate
- Cramer-Rao inequality
- Unbiased linear estimate
- Gaussian White Noise

Chapter 4. Radar Principle **(2 weeks)**
- Introduction
- Basic concepts
- Target Models
- Shift-Doppler

Chapter 5. CFAR Constant False Alarm Rate Detection **(3 weeks)**
- Principles of adaptive detection
- Target Models
- Types of CFAR Detectors

Chapter 6. Distributed CFAR detection **(2 weeks)**
- Distributed CA-CFAR detection
- Merge Setups
- Merge rules

Assessment method:

Review: 100%.

Bibliographic references:

1. *Tsakalides, P., Trinci, P. and Nikias, CL, "Performance Assessment Of CFAR Processors In Pearson-Distributed Clutter", IEEE Transactions on Aerospace and Electronic Systems, vol. AES-36, no. 4, October. 2000, p. 1377-1386.*
2. *Tourneret, J., "Detection And Estimation Of Abrupt Changes Contemned By Multiplicative Gaussian Noise", Signal Processing, 68, p.p. 259-270, 1998.*

III - Detailed program by subject of the semester S3

Semester: 3
Course Unit: UEF 2.1.1Subject 2:
Wireless networks and mobile networks
VHS: 67h30 (Course: 3h00, TD: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives

This subject is devoted to wireless networks (WiFi and WiMAX) and 3 and 4G mobile radios. At the end of the course, the student will have a complete concept of these networks (architecture, radio interface, radio channel, sizing and planning, services offered, security management, roaming, etc...).

Prior knowledge recommended :

TCP Networks, Digital Communications, Telephony.

Material content:

Chapter 1. Reminders of basic concepts (2 weeks)

Reminders and definitions, Types of wireless communications, Modern wireless communications systems, Wireless networks and mobile networks, The concept of cellular networks, Architectures. Base stations, Frequency bands.

Chapter 2. Wireless Personal Area Networks (WPAN) (2 weeks)

Standards and characteristics, Ultra-Wide Band or UWB, Standard 802.15, Bluetooth, Zigbee, Access techniques, Implementation, Security. Some examples: WBAN (Wireless Body Area Networks), WSN (Wireless Sensor Networks) etc.

Chapter 3. Wireless LANs: IEEE 802.11 (Wifi) (3 weeks)

Standard 802.11, Architecture and Layers, 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac or high-speed WiFi, etc., Routing and Transmission Techniques: Architecture of the 802.11 Mode with infrastructure, Installation conditions of the points of access. Architecture of 802.11 Mode without infrastructure, ad-hoc, Security.

Chapter 4. Metropolitan Wireless Networks (2 weeks)

WMAN, Architecture and Evolution,Local Multipoint Distribution Service (LMDS), Multichannel Multipoint Distribution System (MMDS), main characteristics of the IEEE 802.16 Standard,WiMAX, spectral options, WiMAX Subscriber Stations, WiMAX Base Stations, WiMAX technical solutions.

Chapter 5. 3G, 4G and 5G mobile networks (4 weeks)

Structure of a mobile radio system, mobile radio coverage (pico cellular, micro cellular, satellite),Reminders on previous generations (EDGE, GSM, GPRS, services offered: sms, etc.), The different 3G standards, Technologies and characteristics, UMTS, WCDMA, CDMA2000, TD-SCDMA. LTE architecture, LTE Advanced, Characteristics and performance, Standardization, Evolution of cellular technologies, futuristic view of the 5th generation (frequency plan, throughput, latency, etc.). Chapter 6. Introduction to Cognitive Radio **(2 weeks)**

Problem (saturated and misused frequency spectrum), History of Cognitive Radio (CR), Architecture, Cognition cycle, Components, Functions (Spectrum detection or Spectrum sensing, Spectrum management or Spectrum management, Spectrum mobility or Spectrum mobility).

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. Lin, YB, & Chlamtac, I. (2008). Wireless and mobile network architectures. John Wiley & Sons.2, 2008.
2. Gast, M. (2005). 802.11 wireless networks: the definitive guide. "O'Reilly Media, Inc.", 2005.
3. K. Al Agha, (2016) Wireless and Mobile Networks, Wiley, 2006.
4. AKNayak, SCRai, R.Mall, (2016), Computer Network Simulators Using NS2, Productivity Press, 2016.
5. R.Mutha, (2013), Performance Evaluation of AdHoc Routing Protocols By NS2 Simulation, LAP Lambert Academic Publishing, 2013.
6. G. Baudoin, "Digital Radiocommunications T1: Principles, Modeling and Simulation," Dunod, Paris, 2007
8. S. TABBANE, Mobile Networks, Hermès science publications, 1997.

9. Stéphane Lohier, Dominique Present. Networks and transmissions - 6th edition. Protocols, infrastructures and services. NFO SUP, Dunod January 2016.
10. Aurelien Geron. Professional Wi-Fi. The 802.11 standard, deployment, security. Dunod 09/23/2009
11. Pujolle, " THE Networks ", Ed Eyrolle, 8th editing, 2014.

Semester: 3
Course unit: UEF 2.1.1 Subject 1:
Optical communications
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The purpose of this subject is to be able to design and analyze optical communication systems, and especially optical fiber transmissions.

Recommended prior knowledge:

Basic notions of optoelectronics provided at the level of the third year Telecommunications license.

Material content:

Chapter 1. Introduction to Optical Communications Systems (2 weeks)

- Introduction and brief history
- Evolution of optical communications systems
- Advantages of fiber optics

Chapter 2. Study of propagation in optical fibers (2 weeks)

- Geometric approach: Fermat's principle and Snell-Descartes' law - Application to optical fibers (Notion of numerical aperture - Multimode and monomode fibers)
- Wave approach: Maxwell's equations (Modes of a step-index fiber, Comparison between single-mode and multi-mode fibers)

Chapter 3. Electro-optical Transmitters/Receivers (3 weeks)

- Semiconductor light sources - Optical emitters: LED diodes, Laser diodes - Optical receivers: PIN photodiode, Avalanche diode
- Sources of noise and signal-to-noise ratio

Chapter 4. Optical fiber transmission system (4 weeks)

- Synoptic diagram of an optical transmission chain
- Optical cable and connectors
- Structure and families of digital links: point-to-point, with EDFA optical amplifiers, multiplexed links (WDM, OTDM, etc.).

Chapter 5. Fiber Optic Networks (4 weeks)

- Passive and active networks,
- Different FTTX architectures
- Local, metropolitan and long distance optical networks, Passive optical networks (PON), Topologies of optical networks, Power budget of an optical network, performance of an optical network.
- Bragg gratings for an optical encoding and decoding system

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. Govind P. Agrawal, "Fiber-optic communication systems", 4th Edition, John Wiley & Sons, 2010.
2. Gerd Keiser, 'Optical Communications Essentials', McGraw-Hill Companies, 2003.
3. Pierre Lecoy, "Fiber-optic communications", 3rd edition, John Wiley & Sons, 2008.
4. Enrico Forestieri, "Optical communication: theory and techniques", Springer, 2005.
5. Shiva Kumar and M. Jamal Deen, "Optical fiber communications: Fundamentals and applications", John Wiley & Sons, 2014.
6. Govind P. Agrawal, "Lightwave technology: Telecommunication systems", John Wiley & Sons, 2005.
7. John M. Senior, "Optical fiber communications: Principles and practice", 3rd edition, Prentice Hall, 2009
8. Le Nguyen Binh, 'Optical fiber communications systems, Theory and Practice with MATLAB® and Simulink® Models', CRC press, 2010.
9. Michael Barnoski, 'Fundamentals of optical fiber communications, Academic press, 2nd, 1981.
10. AMASWAMY, R., SIVARAJAN, KM, Optical Networks: A Practical Perspective, 3rd Edition, Morgan Kaufmann Publishers, 2010.

Semester: 3
Course Unit: UEF 2.1.2 Subject 3:
Technology and protocols for multimedia
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The objective of this subject is to familiarize students with the various protocols for multimedia as well as the associated technology and applications.

Recommended prior knowledge:

The different types of networks. Coding and Compression, Digital Communications

Content of the subject :

Chapter 1. Multimedia Analysis: Standards and Protocols (3 weeks)
Definitions, standardization, examples of standards, Multimedia and hypertext, foundations of multimedia, Components of Multimedia, Diversity of multimedia applications and needs, Internet (structure and vision). IP, UDP, RTP, TCP/IP, RTSP, Multicast, Resource Reservation, etc.

Chapter 2. Multimedia Signals (3 weeks)
Sound (Tone or pitch, Intensity, timbre, Duration, spectral analysis, etc.), Image, video. Reminders on image compression. Description of Audio Signal Compression. Introduction to video compression. Format change issue. Edition of multimedia documents.

Chapter 3. Media synchronization techniques (3 weeks)
Principle and definition. Local approaches, distributed approaches. Indexing of multimedia files by content. Interactions in multimedia applications.

Chapter 4. Introduction to Access Techniques (3 weeks) The categories of transfer networks, The different types of transmission and multiplexing, The telephone network, Switching networks, Access networks: SDH and WDM technologies, Architectures in the local loop: fiber, HFC cable networks, networks XDSL and LMDS radio links.

Chapter 5. Network Services and Security (3 weeks)
http protocol, electronic messaging, file transfer, telephony over IP, video over IP, quality of service QoS, interactive television. Encryption and Encryption. Watermarking digital data. Steganography. Security in networks

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. Marc Van Droogenbroeck. Multimedia, telecommunications and Internet technologies, University of Liège, 2004
2. S. Collin,. Multimedia on PC, Dunod, Paris, 1994.
3. E. Holsinger, How multimedia works, Ziff-David Press, Emeryville, California, 1994.
4. C. Servin, Networks and telecoms, Dunod, Paris, 2003.
5. S. Déon, IP telephony, Eyrolles, 2010.
6. G. Pujolle, Networks, Eyrolles, 2000.
7. O. Hersent, Voice over IP: Deployment of architectures, Eyrolles, 2006.

Semester: 3
Course Unit: UEF 2.1.2 Subject 4:
Devices (Passive/Active) RF and Microwave
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This subject aims to provide the basic notions and an introduction to the tools necessary for the design of various RF or microwave circuits. These circuits are divided into two types, passive devices such as transmission lines, metal waveguides, couplers, dividers and other active devices such as FET transistor, Schottky diode, mixers and oscillators.

Recommended prior knowledge:

Analog Electronics, Digital Electronics and transmission line.

Content of the subject :

Chapter 1. Passive Microwave Circuits and Devices (4 weeks)
- Notions on S parameters
- Multipole
- Coupled lines (Directive couplers)
- Circulators, Magic Tee, Hybrid, Power Dividers, Directional Couplers
- Adapters, attenuators, phase shifter
- Analysis methods (S parameters, fluence graph)

Chapter 2. Microwave filters (2 weeks)
- Resonant Circuits, Cavities
- Ferrite elements and devices for non-reciprocal passive circuits

Chapter 3. Stability and Noise in Quadrupoles (2 weeks)
- Unconditional stability, Conditional stability, circles of stability (on the Smith chart), Rollet factor

Chapter 4. Gain of a Quadrupole (3 weeks)
- Description of the different gains (power gain, transducic gain and specific gain)
-Design of a linear amplifier
- Design of a low noise amplifier (LNA)

Chapter 5. Microwave Active Circuits and Devices (3 weeks)
- RF diodes (Schottky, Gunn, Varicap, PIN),
- RF transistors (MOSFETs and MESFETs)
- Oscillators and mixers

Chapter 4. Microwave Integrated Circuits (1 week)

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. PF Combes '' Microwaves '' Volume 2, Dunod 96.
2. PFCombes, J.Graffeuil, JFSautereau''Components, devices and microwave active circuits, Dunod University, 1985.
3. A. Pacaud, "Radio frequency electronics", Ellipses.
4. PFCombes ''Medium and centimetric waves Lines, passive circuits, antennas Dunod university.
5. M. Helier, Microwave Techniques, Ellipses.

Semester: 3
Course unit: EMU 2.1 Subject 2:
TP Wireless networks and mobile networks
VHS: 22h30 (TP : 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Master the different techniques of wireless and mobile transmissions as well as the testing of the different corresponding networks.

Recommended prior knowledge:

Fixed and mobile communications systems.

Material content:

Exercise 1: Installation and analysis of a Bluetooth network (WPAN)

Practical work 2: Installation and analysis of a Wifi type network (WLAN) with infrastructure and without infrastructure (ad-hoc)

Practical work 3: Simulation of a WiMAX network, WiMAX station configuration: user and Quality of Service (QoS) management, etc.

Practical work 4: Spectral analysis of wireless networks and measurement of the electromagnetic field (using as far as possible a spectrum analyzer, an RF wattmeter, an electromagnetic field detector, etc.).

TP5: Supervision and evaluation of the quality of service of a 2G, 3G radio network and, as far as possible, 4G.

TP 6: Simulation and planning of mobile radio networks using software (Example ATTOL).

Assessment method:

Continuous control: 100%

Bibliographic references:

1. Lin, YB, & Chlamtac, I. (2008). Wireless and mobile network architectures. John Wiley & Sons.2, 2008.
2. Gast, M. (2005). 802.11 wireless networks: the definitive guide. "O'Reilly Media, Inc.", 2005.
3. K. Al Agha, (2016) Wireless and Mobile Networks, Wiley, 2006.
4. AKNayak, SCRai, R.Mall, (2016), Computer Network Simulators Using NS2, Productivity Press, 2016.
5. R.Mutha, (2013), Performance Evaluation of AdHoc Routing Protocols By NS2 Simulation, LAP Lambert Academic Publishing, 2013.
6. G. Baudoin, "Digital Radiocommunications T1: Principles, Modeling and Simulation," Dunod, Paris, 2007
8. S. TABBANE, Mobile Networks, Hermès science publications, 1997.
9. Stéphane Lohier, Dominique Present. Networks and transmissions - 6th edition. Protocols, infrastructures and services. NFO SUP, Dunod January 2016.
10. Aurelien Geron. Professional Wi-Fi. The 802.11 standard, deployment, security. Dunod 09/23/2009
11. Pujolle, "The Networks", Ed Eyrolle, 8th edition, 2014.

Semester: 3
Course unit: EMU 2.1 Subject 1:
TP Optical communications
VHS : 22h30 (TP : 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

This subject allows students to develop a functional description of fiber optic communication chains, emphasizing the main limitations introduced by the various optical components (fiber, laser source, optical amplifier, etc.)

Recommended prior knowledge:

Notions on analog and digital modulations; Signal processing.

Material content:

TP1: Chromatic dispersion and its compensation

TP2: Modulation/demodulation in optics

TP3: Mono-wavelength point-to-point link

TP4: Study of an OTDM link

TP5: Study of a WDM link

Assessment method:

Continuous control: 100%

Bibliographic references:

1. Govind P. Agrawal, "Fiber-optic communication systems", 4th Edition, John Wiley & Sons, 2010.
2. Gerd Keiser, 'Optical Communications Essentials', McGraw-Hill Companies, 2003.
3. Pierre Lecoy, "Fiber-optic communications", 3rd edition, John Wiley & Sons, 2008.
4. Enrico Forestieri, "Optical communication: theory and techniques", Springer, 2005.
5. Shiva Kumar and M. Jamal Deen, "Optical fiber communications: Fundamentals and applications", John Wiley & Sons, 2014.
6. Govind P. Agrawal, "Lightwave technology: Telecommunication systems", John Wiley & Sons, 2005.
7. John M. Senior, "Optical fiber communications: Principles and practice", 3rd edition, Prentice Hall, 2009
8. Le Nguyen Binh, 'Optical fiber communications systems, Theory and Practice with MATLAB® and Simulink® Models', CRC press, 2010.
9. Michael Barnoski, 'Fundamentals of optical fiber communications, Academic press, 2nd, 1981.
10. AMASWAMY, R., SIVARAJAN, KM, Optical Networks: A Practical Perspective, 3rd Edition, Morgan Kaufmann Publishers, 2010.

Semester: 3
Course unit: EMU 2.1 Subject 3:
TP Technology and protocols for multimedia
VHS : 22h30 (TP : 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The objective of this subject is to introduce students to the components and mechanisms of multimedia, to analyze and monitor the various elements of multimedia data chains.

Recommended prior knowledge:

The different types of networks. Coding and Compression, Digital Communications

Material content:

TP 1: Monomedia processing: audio standards (for example MPEG-2 layer 3) TP
2: Multimedia processing: compression standards (MPEG 1-2, MPEG-4)
TP 3: development of multimedia applications. Implementation in Java or in MATLAB TP
4: Implementation of an audio and/or video indexing technique
Practical work 5: Study and evaluation of multimedia communications protocols and quality of service (QoS) using Video LAN client (VLC) in a local area network (LAN and WLAN)
TP6: Study and implementation of a technique for encryption, watermarking and/or digital data steganography

Assessment method:

Continuous control: 100%

Bibliographic references:

1. Marc Van Droogenbroeck. Multimedia, telecommunications and Internet technologies, University of Liège, 2004
2. S. Collin,. Multimedia on PC, Dunod, Paris, 1994.
3. E. Holsinger, How multimedia works, Ziff-David Press, Emeryville, California, 1994.
4. C. Servin, Networks and telecoms, Dunod, Paris, 2003.
5. S. Déon, IP telephony, Eyrolles, 2010.
6. G. Pujolle, Networks, Eyrolles, 2000.
7. O. Hersent, Voice over IP: Deployment of architectures, Eyrolles, 2006.

Semester: 3
Teaching unit: UEM 2.1 Subject 4:
Digital Television
VHS: 37h30 (Course: 1h30, TP:
1h00)
Credits: 3

Teaching objectives:

The student will understand the principle of digital television (transmission and image processing) and its applications as well as the notions of digital compression and coding.

Recommended prior knowledge:

Knowledge of electricity, basic electronics and electromagnetism are necessary to follow this subject. This knowledge is provided at the level of the ST common core and the third year of the license training of this training.

Material content:

Chapter 1. Reminders on analog television (2 weeks)

History, Colorimetric standards for color video, Color analog composite video signal, Chrominance submodulation, Color coding/decoding techniques (PAL, SECAM and NTSC), Transmission bands and channels for analog television (VHFI, VHFIII and UHF) , Reminders on current standards.

Chapter 2. Digitizing Video and Audio Signals (3 weeks)

Reminders on the sampling and quantification of signals, Dynamics and digitization of Y, Cr and Cb components, The different digital video formats (4:2:2, 4:2:1, 4:2:0). The digital video line, the digital video frame. Digital video standards and definitions in p and/or i (SD, HD, Full HD, 4K2K, etc.). Digitization of the audio signal.

Chapter 3. Video and audio compression techniques (5 weeks)

Introduction, Calculation of digital video transmission rates, Spatial redundancy and temporal redundancy, Principle of intra-image compression (Transformation-Quantification-Coding), Inter-image compression: motion analysis, motion compensation, Video compression standards: MPEG2, MPEG4, H264/AVC and HEVC. Audio compression techniques. Signal multiplexing.

Chapter 4. Digital Televisions (5 weeks)

History and context, Different types of digital television (DVB-T, DVB-S and DVB-C), Block diagrams. Transmission and broadcasting of digital television (DVB); COFDM for DVB-T, The digital modulations used. DVB-T channels. Digital TV reception.
Other digital terrestrial broadcasting standards (ATSC, ISDB-T and DMB-T, etc.). New generations like DVB-T2, DVB-NGH…etc

List of practical work

TP1: Reminders on analog television: bands and channels, characteristics of the color composite video signal, etc.

TP2: Satellite TV reception (occupied frequency bands, pointing of the dish on an example of a satellite, azimuth angle, degree of elevation, angle of polarization, field measurements, role of the LNB, interests of horizontal polarization and vertical, spectrum analyzer, etc.)

TP3: Evaluation of DTT reception (Digital Terrestrial Television): DTT decoder, spectrum analyzer and/or field strength meter (if the equipment exists)

TP4: Study, implementation and evaluation of MPEG2 under Matlab

TP5: Study, implementation and evaluation of COFDM under Matlab

TP6: Implementation under simulink of DVB-T

Assessment method:

Continuous control: 40%; Review: 60%.

Bibliographic references:

1. *Stéphane Paris, ''Multimedia and compression''. Publisher: Hermès-Lavoisier*
2. *Andrey Cernasov. ''Digital Video Electronics with 12 complete projects''. Publisher: McGraw Hill 2009*
3. *Ulrich Reimers. ''DVB The Family of International Standards for Digital Video Broadcasting''. Publisher: Springer 2004*
4. *Herve Benoit. ''Analog and digital satellite television''. Publisher: Dunod 2005*
5. *Herve Benoit. ''Digital Satellite, cable, terrestrial television - Principles and applications of the DVB system''. Publisher: Dunod 2005*
6. *John Herben. ''PAL and SECAM color television From analogue to digital''. Publisher: Dunod 2003*
7. *Herve Benoit. ''Digital television Satellite, cable, TNT, ADSL, mobile TV''. Publisher: Dunod 2010*
8. *Nicholas Moreau. ''Tools for signal compression''. Publisher: Hermes - Lavoisier 2009.*

Semester: 3
Course unit: UED 2.1 Subject:
Matter 1 of your choice
VHS : 22h30 (cours : 1h30)
Credits: 1
Coefficient: 1

Semester: 3
Course unit: UED 2.1 Subject:
Matter 2 of your choice VHS:
VHS : 22h30 (cours : 1h30)
Credits: 1
Coefficient: 1

Semester: 3
Course unit: UET 2.1 Subject 1:
Documentary research and memory design
VHS : 22h30 (Cours: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives :
Give the student the necessary tools to find useful information to better exploit it in his graduation project. Help him through the different steps leading to the writing of a scientific document. Make him aware of the importance of communication and teach him to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Content of the subject:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (02 weeks)
- Subject title
- List of subject keywords
- Gather basic information (acquisition of specialized vocabulary, meaning of terms, linguistic definition)
- The information sought
- Take stock of your knowledge in the field

Chapter I-2: Selecting sources of information (02 weeks)
- Type of documents (Books, Theses, Dissertations, Periodical articles, Conference proceedings, Audiovisual documents, etc.)
- Type of resources (Libraries, Internet…)
- Assess the quality and relevance of information sources

Chapter I-3: Locating documents (01 Week)
- Research techniques
- Search operators

Chapter I-4: Processing information (02 weeks)
- Work organization
- The starting questions
- Summary of selected documents
- Links between different parties
- Final desk research plan

Chapter I-5: Presentation of the bibliography (01 Week)
- The systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Memory Design

Chapter II-1: Dissertation plan and stages (02 weeks)

- Identify and delimit the subject (Summary)
- Problem and objectives of the dissertation
- The other useful sections (Acknowledgements, Table of abbreviations, etc.)
- The introduction (Writing the introduction last)
- State of the specialized literature
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- conclusion and perspectives
- Table of contents
- The bibliography
- Annexes

Chapter II- 2: Writing techniques and standards (02 weeks)

- Formatting. Numbering of chapters, figures and tables.
- Cover Page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- spelling. Improvement of general linguistic competence in terms of comprehension and expression.
- Save, secure, archive your data.

Chapter II-3: Workshop: Critical study of a manuscript **(01 Week)**

Chapter II-4: Oral presentations and defenses (01 Week)

- How to present a Poster
- How to present an oral communication.
- Defense of a dissertation

Chapter II-5: How to avoid plagiarism? (01 Week)

(Formulas, sentences, illustrations, graphs, data, statistics,...)

- The quote
- The paraphrase
- Indicate the complete bibliographic reference

Assessment method:

Review: 100%

Bibliographic references:

1. *M. Griselin et al., Guide to written communication, 2nd edition, Dunod, 1999.*
2. *JL Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.*
3. *A. Mallender Tanner, ABC of technical writing: manuals, user manuals, online help, Dunod, 2002.*
4. *M. Greuter, Writing your dissertation or internship report well, L'Etudiant, 2007.*
5. *Mr. Boeglin, read and write in college. From chaos of ideas to structured text. The Student, 2005.*
6. *M. Beaud, the art of the thesis, Editions Casbah, 1999.*
7. *M. Beaud, the art of the thesis, Discovery, 2003.*
8. *M. Kalika, Master's thesis, Dunod, 2005.*

Proposal of some discovery materials

Semester: 3
Course unit: UED 2.1 Subject 1:
space telecommunication
VHS : 22h30 (Cours: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective of this subject is to present in general the main characteristics of satellite communications systems.

Recommended prior knowledge:

Communication systems.

Content of the subject :

Chapter 1. Principle of satellite transmission (5 weeks)

- Earth and space stations
- Constitution of the satellite (Platform- Payload- Transponder)
- Earth orbits, geostationary orbits, allocated bands
- Earth and space station technology

Chapter 2. Constellation of Satellites (5 weeks)

- Tilted and polar constellations
- Characteristics of the different constellations
- Handover problem
- Optical satellites (Problem of vibration sources: external and internal)

Chapter 3. Assessment of a satellite link and atmospheric disturbances (5 weeks)

- Main parameters of a link: Antenna gain, Loss in free space, Loss by atmospheric absorption, Noise temperature, Noise factor, Equivalent noise temperature at the input of a circuit, PIRE.
- Power density, Power received by an antenna, Telecommunication equation uplink – downlink.
- Main sources of noise in a satellite communication link, C/N0 ratio of a satellite link, Disturbance factors of the quality of a satellite link.

Assessment method:

Review: 100%.

Bibliographic references:

1. *Gerard Maral, Michel Bousquet, Zhili Sun "Satellite Communications Systems: Systems, Techniques and Technology. 5th Edition. 2009*
2. *Journal of Telecommunications, UIT, from 1934 to 1993.*
3. *ITU News, from 1993, http://www.itu/itunews*
4. *ITU Manual on Satellite Communications, 3rd ed., 2002, 1210 p.*
5. *BENSOUSSAN, Alain, Telecoms and the law, Paris, Hermès, 2nd ed., 1996, 205 p.*
6. *Aerospace Law: Telecommunications Satellites, Montreal, McGill University, 1982, 354 p.*

Semester: 3
Teaching unit: UED 2.1 Subject 1:
Radio navigation system
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective of this material is to present in general the main characteristics of satellite radionavigation systems, their applications, advantages and disadvantages.

Recommended prior knowledge:

Communication systems, Signal processing.

Content of the subject :

Chapter 1. Satellite radio navigation systems (5 weeks)

- History, Terrestrial radio navigation systems (VOR, TACAN, DME, ILS, MLS, LORAN).
- Presentation of the GPS system and GPS signals (Functional architecture of a receiver, Principle of GPS measurement: pseudo distances, pseudo speeds, Calculation of GPS position and speed, Specificities of military GPS receivers: cryptographic modules, direct acquisition in code Y, interference resistance).

Chapter 2. GPS Enhancements and Future Systems (5 weeks)

The limitations of GPS: integrity, resistance to interference, masking, precision, Techniques for improving GPS: differential techniques, integrity check, increase in constellation, improvement of resistance to interference, etc. The Galileo system and other systems of satellite navigation (existing or to come).

Chapter 3. Non-inertial sensors for navigation (5 weeks)

- Vision sensors (IR, visible, stellar camera), Movement sensors (odometer, correlation log), speed sensors (log, doppler, anemometry), Distance sensors (radar, sonar, depth sounder), Altitude sensors or immersion, Magnetic field sensors, Hybrid inertial systems.
- Integration of the CNS concept on board modern aircraft.

Assessment method:

Review: 100%.

Bibliographic references:

1. *Gerard Maral, Michel Bousquet, Zhili Sun "Satellite Communications Systems: Systems, Techniques and Technology. 5th Edition. 2009*
2. *ITU Manual on Satellite Communications, 3rd ed., 2002, 1210 p.*
3. *Aerospace Law: Telecommunications Satellites, Montreal, McGill University, 1982, 354 p.*
4. *L.Andrade. The Global Navigation Satellite System: Navigating into the New Millennium (Ashgate Studies in Aviation Economics and Management), Ashgate Pub Ltd, 2001, ISBN: 0754618250*