INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES

Academic year 2020/2021

Courses offered by the programme

Systèmes et Réseaux de Communications (SRC)
Communication Systems and Networks

Semester(s) : 7-8-9-10

Curricula are organized in groups of courses (Unités d'Enseignement (UE)), consisting of several courses (Eléments Constitutifs (EC)). An EC is a teaching module including lectures (cours magistraux (CM)), tutorials (travaux dirigés (TD)), laboratory work (travaux pratiques (TP)), projects (PR), conferences (CONF), personal work (TA) and possibly other pedagocial activities (DIV). Some internships (stages (ST)) are compulsory

Commonly used abbreviations
CM : Lectures
TD : Tutorials
TP : Laboratory Work
CONF : Conferences
TA : Personal Work
PR : Project
ST : Internship
DIV : Miscellaneous

Code	Libelle
EII09-AHD	Advanced Hardware Design
EII09-VIS	Computer Vision
M&N09-PROJ	Technical project
SRC09-IRHINT	Integration and reconfigurability
SRC09-IRHPL	Deterministic tools for planning and optimizing wireless networks
SRC09-IRHPROJ	Project
SRC09-NETLAB	Network lab training
SRC09-PRCNUM	Digital Communications prerequisites
SRC09-REALTIME	Real Time Processing
SRC09-SOPC	System on Programmable Chips
SRC09-SYSLAB	Digital Systems Lab
SRC09-TCANT	Network antennas
SRC09-TCCEM	Electromagnetic compatibility (EMC). Electromagnetic compatibility (EMC). Electromagnetic compatibility (EMC).
SRC09-TCCOMP	Multicarrier modulations
SRC09-TCCROSS	Cross Layer
SRC09-TCETA	Spread Spectrum Techniques

List of courses with handout in English or that can be taught in English

Non-Linear Electronic Systems	SRC07-ESNL
Number of hours : 52.00 h	4.00 ECTS credit
CM : 4.00 h, CM : 18.00 h, TD : 10.00 h, TP : 4.00 h, TP : 16.00 h	
Reference Teacher(s) : MERIC STEPHANE	

Objectives :
Useful methods for the study of non-linear systems. How to comprehend phenomenon occurring in non-linear systems.
Application - examples.

Content :
1. Fundamentals for non-linear systems. General behaviour of non-linear systems according to initial conditions. Signal distortion, distortion rate calculation.
2. First harmonic operating approximation method: scattered characteristics case, common method for some characteristics.
3. Non-linear looped systems, Nyquist and critical points method, auto-stabilisation of oscillations in a looped system.
4. Global study method in phase plane: singular points, limit cycles, cartography in phase plane, influence of initial conditions on system behaviour.
5. Study of some non-linear systems, multiplication circuits, frequency multipliers, modulation and demodulation circuits.
6. Description and study of a Phase Locked-Loop: Introduction and description of the different parts of the PLL, methods for designing the loop-filter, the phase detector and the voltage control oscillator, study of different applications (frequency demodulation, asynchronous amplitude demodulation, frequency synthesis).
7. Description of the ADC and DAC characteristics: Gain, transfert function, quantum, conversion errors. Description of the different technologies for ADC (flash, parallel, ramp technics, Delta-Sigma) and for DAC (weighted resistances, R-2R network, inversed network R-2R, weighted currents).

Bibliography :
Analyse numérique et équations différentielles, Jean-Pierre Demailly, Presses Universitaires de Grenoble
Systèmes non linéaires, A. FOSSARD, Publication de cours SUPAERO, Toulouse
Electronique : fonctions principales et systèmes intégrés, Jean-Marc POITEVIN, Dunod.
Principes de conversion : analogique-numérique et numérique-analogique, Jean-Paul TROADEC, Dunod

Requirements :
Resolution methods for second order differential equations with constant coefficients, SRC06-PRER module.
Looped systems analysis (stability and oscillations), SRC06-SL module.

Organisation :
Revision of class notes and practical exercises. Problem solving.

Evaluation :
2 two-hour written examinations.
Mark for practical work.

Target :

Digital Signal Processing	SRC07-DSP
Number of hours : 24.00 h	2.00 ECTS credit
CM : 8.00 h, TD : 8.00 h, TP : 8.00 h	
Reference Teacher(s) : UZEL FABIENNE	

Objectives :
Digital signal processing. Used of Texas C6X family C6416X

Content :
1- Introduction to DSP
2- Architecture VLIW and others parallelism
3- Pipeline and spatial parallelism
4- DMA transfer
5- Interruption mechanism

Bibliography :
Texas instrument data book,
Texas Instrument Web site and on line courses
Chayssing digital signal processing

Requirements :
SRC06-ARCHI, SRC05-LANGC

Organisation :
homework

Evaluation :
Practice and 1 examination of 1H

Target :

CDC Project	SRC07-CDC
Number of hours : 8.00 h	1.50 ECTS credit
PR : 8.00 h	
Reference Teacher(s) : LEMOINE CHRISTOPHE	

Objectives :
Definition of the electronic student project

Content :
THe students are organized in group (6 students). They have to propose to work on a subject in electronic field. during this first semestria, they have to :
- analyse the existing solutions if already in use
- propose technical solutions
- propose a schedule of the projet realized during 2nd semestria
- analyse the cost (human and material costs)
- analyse the possible difficulties and alternative solutions

Bibliography :
Previous students projects since 2002

Requirements :
3 and 4 SRC lessons

Organisation :
Home work

Evaluation :
report and presentation

Target :

Detection and estimation / Information Theory	SRC07-DETIC
Number of hours : 58.00 h	4.50 ECTS credit
CM : 20.00 h, CM : 20.00 h, TD : 4.00 h, TD : 6.00 h, TD : 8.00 h	
Reference Teacher(s) : ZAHARIA GHEORGHE	

Objectives :
Introduction to detection, estimation, information theory and channel coding techniques and their applications.

Content :
1. Detection and Estimation: Bayes method, min-max criterion, maximum a posteriori criterion: Fundamentals of binary detection statistical theory: scalar and vector cases. Statistical hypothesis testing, Neyman-Pearson method.
Receiver operating characteristic. Case of multiple hypotheses. Case of band-limited signals. Estimation of deterministic parameters (scalar or vector). Maximum likelihood criterion. Estimation of random parameters. Estimator quality Cramer-Rao criterion, efficient estimator.

2. Information theory. Introduction to information theory. Entropy and mutual information. Information sources with and without memory: examples of Markovian sources. Entropy of a stationary source with and without memory. Source coding: presentation of fundamental source coding theorem, Huffman coding. Transmission channel capacity and fundamental channel coding theorem. Capacity of a stationary channel without memory, with discrete input and analog output.

3. Coding
Introduction to channel coding. Bloc codes: definition and general properties of linear block codes. Generator and parity check matrices. Detection and correction of transmission errors. Minimum distance and performance of bloc codes. Some examples of linear block codes. Cyclic bloc codes. Definition. Some examples. Decoding technics. Error probability of block codes. Performance and coding gain.

Convolutional codes. Main principles of the convolutional codes. Tree, trellis and state diagrams. Decoding of convolutional codes. The Viterbi algorithm. Performance of the convolutional codes. Punctured convolutional codes. Examples and applications of the convolutional codes.

Bibliography :
1. H. Van Trees, "Detection, Estimation and Modulation Theory", Part I, Dover, 1994.
2. H. Urkowitz, "Signal theory and random processes", Artech House, 1983.
3. A. Spataru, "Théorie de la transmission de l'information", Presses polytechniques et universitaires romandes, 1987.
4. J. G. Proakis., "Digital communications", 6th Edition, Mc Graw-Hill Int. Editions, 2003. Communication systems, S. Haykin, John Wiley & Sons, 2001.
5. A. Glavieux, M. Joindot, "Communications numériques", Collection pédagogique des Télécommunications, Masson, 1996.
6. S. Benedeto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions.

Requirements :
ESC05-PRER, ESC05-TTSIA, SRC06-COMSYS, SRC07-CNUM1 modules.

Organisation :
Revision of lecture and practical work notes.

Evaluation :
2 two-hour written examinations.

Target :
4SRC students

Radiocommunications Basics	SRC07-RADIO1
Number of hours : 28.00 h	2.00 ECTS credit
CM : 20.00 h, TD : 8.00 h	
Reference Teacher(s) : EL ZEIN GHAIS	

Objectives :
"Study of different propagation phenomena and radio links.
Characterisation and modelling of radiowave channels.

"

Content :
"1. Introduction to radio communications: free space propagation, receiving power, characteristics of antennas, link power budget, interference.

2. Modelling the environment: ground waves, ground reflections, atmospheric refraction, tropospheric scattering, diffraction, rain and vegetation effects, depolarisation, multipath and fading, prediction models.

3. Radio links: ionospheric, tropospheric, satellite and mobile radio links.

4. Characterisation of nonstationary transmission channels: time, frequency and time-frequency domains, Doppler, delay.
5. Diversity reception techniques: space, frequency, time, polarisation, multipath and arrival angle diversities.

"

Bibliography :
1. J. Rappens, M. Picasso "" Introduction à l'analyse numérique "", Presses polytechniques et universitaires romandes, 1998
"L. Boithias, """"Propagation des ondes radioélectriques dans l'environnement terrestre""""", Dunod
84.

Introduction aux radiocommunications, G. El Zein, document polycopié."

Requirements :
SRC05-WTLB (Waves and Transmission Lines Basics)
SRC06-EWAB (Electromagnetic Waves and Antennas Basics)

Organisation :

Evaluation :
2-hour written exam.

Target :
4th year (=1st year of Master degree)

Micro-ondes - Bases / Microwave Basics	SRC07-MB
Number of hours : 34.00 h	2.50 ECTS credit
CM : 10.00 h, CM : 16.00 h, TP : 8.00 h	
Reference Teacher(s) : FOURN ERWAN	

Objectives :
"- Further the study and the frequency and time analysis of microwave transmission lines
- Become familiar with analysis and synthesis techniques of microwave circuits
- Learning to simulate and design electronic circuits on the main technologies in microwaves"

Content :
I) Transmission lines (10h, lectures and exercises)
a) Analysis tools: standing wave ratio, transmission line impedance equation, special lines (quarter-wave and half-wave), Smith chart, etc.
b) Impedance matching circuits (lumped elements, quarter-wave transformer, series or shunt stub(s)), microstrip and coplanar technologies
c) Reflectometry

II) Microwaves circuits (16h, lectures and exercises)
a) Scattering matrix
b) Signal flow graph and Mason rule
c) Linear amplifier (stability, power matching, gain, noise) - Application to a single-stage narrow-band amplifier

III) Pratical work (8h)
4 sessions on the simulation software ADS (Keysight) to study and design active and passive components.
Learing of circuit and electromagnetic simulation techniques

Bibliography :
- "Microwave Engineering", D.M. Pozar, Whiley

Requirements :
SRC05-WTLB (Waves and Transmission Lines Basics)
SRC06-EWAB (Electromagnetic Waves and Antennas Basics)

Organisation :

Evaluation :
2-hour written exam (including questions about the project) - Possible short random exams during lectures to capitalize bonus marks.

Target :
4th year (=1st year of Master degree)

Digital Communications I	SRC07-CNUM1
Number of hours : 42.00 h	3.50 ECTS credit
CM : 22.00 h, TD : 10.00 h, TP : 10.00 h	
Reference Teacher(s) : HELARD MARYLINE	

Objectives :
An overview of the principles of digital communication.

Content :
1. History and principles of digital communications. Properties of digital communications.
2. From analog to digital communications. Classification of digital modulations Pulse modulation.
3. Details of a digital communication chain. Rate and spectral efficiency. Capacity.
4. Power spectral density of digital signal. Application to line codes and linear dogital modulations.
5. Optimal receiver and performance for illimited bandwidth base band signal transmission.
6 Digital modulations. Optimal receiver and performance for modulated signal transmission. (ASK, PSK, FSK, MSK, QAM, etc).
7. 6h Lab work: study of a digital transmission channel using Ptolemy.

Bibliography :
J. G. Proakis., ""Digital communications"", 6th J. G. Proakis., ""Digital communications"", 6th Edition, Mc Graw-Hill Int. Editions, 2003.
S. Beneddeto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions
Communications numériques, M. Hélard, document polycopié.

Requirements :
SRC05-PRER ,SRC06-TSIA, SRC07-DESTI and SRC07-SINUM modules.

Organisation :
Revision of lecture notes and practical exercises.

Evaluation :
2 two-hour written examinations. Mark for practical work and continuous control.

Target :

VHDL	SRC07-VHDL
Number of hours : 24.00 h	2.00 ECTS credit
CM : 10.00 h, TD : 6.00 h, TP : 8.00 h	
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Design of digital circuits in VHDL: design, simulation, logic synthesis and test.

Content :
VHDL language syntax; behaviour, data flow and structural domains. Modelling of digital circuits. Simulation (notion of
test-bench), circuit synthesis, test. Design flow applied to programmable logic circuits. Practical work on FPGA circuits
(circuit design).

Bibliography :
La langage VHDL -Jacques Weber, Maurice Meaudre - Dunod Initiation au langage VHDL - Michel Aumiaux - Dunod.

Requirements :
ESC06-LPROG.

Organisation :
Revision of lecture notes. Preparation of practical work.

Evaluation :
Written examination. Mark for practical work.

Target :

C++ Object Oriented Programming	SRC07-INFOC++
Number of hours : 26.00 h	2.00 ECTS credit
CM : 14.00 h, TP : 12.00 h	
Reference Teacher(s) : ANQUETIL ERIC	

Objectives :
Object-oriented programming is a powerful tool in the design and development of "real software applications". It provides a
more reliable means of defining substantial projects while ensuring efficient follow-up of the different stages in their
development. It highlights the fundamental principles associated with C++ object-oriented programming.

Content :
Basic knowledge of C++ object and class: object construction, interface, encapsulation, etc. Memory management mechanisms: dynamic memory allocation, destructor, allocation, copy construction. I/O management. C++ object-oriented
design: inheritance, polymorphism, access controls, etc. Multiple inheritance, template. STL. Exception management. Internal
class. Frameworks programming and use.

Bibliography :
Conception oriented objects and applications- G. Booch - Addison-Wesley The C++ programming language (third edition) - B. Stroustrup - Addison-Wesley

Requirements :
4-49SPROB pre-specialisation module (Java object oriented programming), ESC06-INFO module.

Organisation :
Revision of lecture notes and preparation of laboratory work.

Evaluation :
Mark for laboratory work.

Target :

English	HUM07-ANGL
Number of hours : 28.00 h	2.00 ECTS credit
TD : 28.00 h	
Reference Teacher(s) : RANNOU ISABELLE	

Objectives :
Acquiring the required skills for working in a firm as an engineer. Reaching the required level (B2) is compulsory in order to graduate.

Content :
-Learning by doing:
The student will have to be able to talk and listen, write documents while showing he/she can solve problems, reason, convince and demonstrate in an articulate manner.
-Expressing oneself accurately and fluently.
The student will engage in activities requiring creative and reactive skills (such as debates, role-plays, individual oral presentations using PowerPoint, projects), which will be based on scientific topics and current events.
-Writing CVs and cover letters
-Scientific English
-Discovering the professional world in an international context
-Preparing for the TOEIC (during the second semester, a specific ¿Toeic Booster¿ course will be available)

Bibliography :
- Oxford Advanced learners¿ Dictionary
- English Grammar in Use (Cambridge University Press)

Requirements :
1st, 2nd and 3rd year English courses (or equivalent)

Organisation :
Each class lasts two hours and most classrooms are equipped with video and audio. A multimedia language lab and computer rooms are also available and make it possible for the students to work in a stimulating environment. Our teaching resources include press articles, audio and video documents (TV reports, extracts from films and series). We also use the Internet.
Regular personal work is obviously required. The student must be curious and practise English outside the classroom as well.

Evaluation :
One two-hour written exam.

Target :

Entrepreneurship and Innovation	HUM07-EI
Number of hours : 48.00 h	3.00 ECTS credit
CM : 24.00 h, TD : 24.00 h	
Reference Teacher(s) : GOURRET FANNY	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Sport and physical education	HUM07-EPS
Number of hours : 24.00 h	1.00 ECTS credit
TD : 24.00 h	
Reference Teacher(s) : LE LAGADEC PIERRE	

Objectives :
Team work, discovery of one's capabilities, communication, invention and management responsibilities.

Content :
Choice of two activities from a menu. Adapting to destabilising situations and taking responsibility when risk is involved.
Speaking to groups. Leading group stretching exercises. Indoors: Rock climbing or badminton in teams. Outdoors: C.O or
Kayak or golf

Bibliography :
Several specialized books are available to the students at the library. Links to internet sites are given on the EPS website.

Requirements :

Organisation :

Evaluation :
Evaluation is based upon student participation, progress and acquisition. The student is asked to criticise his own progress with respect to the objectives of the course. The ability to be self-critical leads to self-discovery. Sharing this knowledge with a group reinforces one's confidence.

Target :

APES Responsabilités associatives à 1 crédit : Mission Diversité	HUMF1-APES DIV
Number of hours : 60.00 h	1.00 ECTS credit
DIV : 7.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 8

Parcours Formation Initiale SRC

1	**SRC08-1**		**Microwaves circuits and antennas**	**5.00**
	SRC08-MW	O	Micro-ondes / Microwaves	2.00
	SRC08-WA	O	Waveguides and Antennas	2.00
	SRC08-RADIO-2	O	Radiocommunications	1.00
2	**SRC08-2**		**Radar Systems and project**	**6.00**
	SRC08-SYRAD	O	Radar Systems	1.50
	SRC08-TSRS	O	Radar and Sonar Signal Processing	2.00
	SRC08-PROJ	O	Electronic Students projects	2.50
3	**SRC08-3**		**Communication Networks**	**5.00**
	SRC08-RES	O	Réseau 2	1.00
	SRC08-CNUM2	O	Digital Communications 2	2.50
	SRC08-MNUM	O	Methods for digital computing	1.50
4	**HUM08**		**Non-scientific syllabus S8**	**6.00**
	HUM08-ANGL	O	English	2.00
	HUM08-ECO	O	Economy and Management	1.00
	HUM08-SHES1	O	Engineer & Society - M1	1.00
	HUM08-SHES2	O	Engineer & Society - M2	1.00
	HUM08-EPS	O	Sport and Physical Education	1.00
5	**SRC08-STAGE**		**Work placement**	**8.00**
	SRC08-STAGE	O	Work Placement	8.00

O = compulsary, C= in choice , F= optional

Micro-ondes / Microwaves	SRC08-MW
Number of hours : 34.00 h	2.00 ECTS credit
CM : 18.00 h, CM : 6.00 h, PR : 10.00 h	
Reference Teacher(s) : GILLARD RAPHAEL	

Objectives :
- Investigate coupled transmission lines - Study main applications of passive microwave circuits (filters, power dividers and couplers) and associated topologies - Give basics of non linear functions (with a focus on power amplifiers).

Content :
1- Theory of coupled lines, 2- Microwave filters, 3- Power dividers and couplers (applications), 4- Power dividers and couplers (topologies), 5- Non linear functions, 6- Power amplifiers

Project (10h)
Analysis, design and characterization of microwave circuits (couplers, filters, etc.). Circuit and fullwave simulations, measurements using Vector Network Analyzer

Bibliography :
"- ""Microwave Engineering"", D.M. Pozar, Whiley
- ""Electromagnetic Waves and Antennas"", S.J. Orfanidis, http://www.ece.rutgers.edu/~orfanidi/ewa/"

Requirements :
"SRC05-WTLB (Waves and Transmission Lines Basics)
SRC06-EWAB (Electromagnetic Waves and Antennas Basics)
SRC07-MB (Microwaves Basics)"

Organisation :

Evaluation :
2-hour written exam (including questions about the project) - Possible short random exams during lectures to capitalize bonus marks.
2-hour written exam (including questions about the project) - Possible short random exams during lectures to capitalize bonus marks.

Target :
4th year (=1st year of Master degree)

Waveguides and Antennas	SRC08-WA
Number of hours : 36.00 h	2.00 ECTS credit
CM : 16.00 h, CM : 10.00 h, TP : 10.00 h	
Reference Teacher(s) : FOURN ERWAN	

Objectives :
"- Complement the electromagnetism theoretical concepts by the study of waveguides
- Be able to analyse and design conventional waveguides and resonant cavities
- Know the main antenna technologies
- Be able to design a basic antenna
- To have a basic knowledge of the metrology in the field of microwae circuits and antennas"

Content :
"I) 3D waveguides (16h, lectures and exercises)
a) Guided propagation : propagation equation and solutions, propagation modes (TEM, TE, TM, etc.), losses.
b) Usual waveguides : rectangular and circular, coaxial and planar lines.
c) Resonant cavities : resonance frequency, electromagnetic analysis.

II) Antenna technologies (10h, lectures and exercices)
a) Wire antennas : dipoles, loops, Yagi, log-periodic, feeding techniques.
b) Radiating apertures : horns and reflectors.
c) Printed antennas basics.

III) Practical work (10h)
Microwave and antenna metrology : spectrum analysis, waveguide and microwave circuit S parameters (vector network analyser), antenna gain and radiation pattern."

Bibliography :
- ""Microwave Engineering"", D.M. Pozar, Whiley
- ""Antenna Theory, analysis and design"", C.A. Balanis, Whiley
- ""Electromagnetic Waves and Antennas"", S.J. Orfanidis, http://www.ece.rutgers.edu/~orfanidi/ewa/"

Requirements :
"SRC05-WTLB (Waves and Transmission Lines Basics)
SRC06-EWAB (Electromagnetic Waves and Antennas Basics)
SRC07-MB (Microwaves Basics)"

Organisation :

Evaluation :
2 hour exam

Target :
1st year of master's degree

Radiocommunications	SRC08-RADIO-2
Number of hours : 13.00 h	1.00 ECTS credit
CM : 2.00 h, TD : 2.00 h, TP : 9.00 h	
Reference Teacher(s) : EL ZEIN GHAIS	

Objectives :
Study of different kinds of propagation and radio links. Characterisation and modelling of radioelectric channels.

Content :
1. Introduction to radio communications: free space propagation, receiving power, characteristics of antennas, link power
budget, interference.
2. Modelling the environment: ground waves, ground reflections, atmospheric refraction, tropospheric scattering, diffraction,
rain and vegetation effects, depolarisation, multipath and fading, prediction models.
3. Radio links: ionospheric, tropospheric, satellite and mobile radio links.
4. Characterisation of nonstationary transmission channels: time, frequency and time-frequency domains, Doppler delay.
5. Diversity reception techniques: space, frequency, time, polarisation, multipath and arrival angle diversities.

Bibliography :
L. Boithias, ""Propagation des ondes radioélectriques dans l'environnement terrestre"", Dunod 84.
Introduction aux radiocommunications, G. El Zein, document polycopié.

Requirements :
ESC05-TTSIA, ESC06-ONDE, ESC06-PROPA, ESC07-CNUM, ESC08-ANTEN.

Organisation :
Revision of lecture and practical work notes. Preparation of practical work.

Evaluation :
2 two-hour written examinations.

Target :

Radar Systems	SRC08-SYRAD
Number of hours : 26.50 h	1.50 ECTS credit
CM : 16.00 h, TD : 6.00 h, TP : 4.50 h	
Reference Teacher(s) : MERIC STEPHANE	

Objectives :
Overview of pulse and continuous-wave Radar systems.

Content :
Radar systems, measurement of speed, measurement of speed and distance combined. Pulse Doppler Radar: principles, distance ambiguity, blind speed, fixed-echo elimination. Correlation Radar systems, pseudo-random code, other coding techniques. Applications.
Half-day practical session: installation of an outdoor pulse Radar, calibration with tetrahedral measurements on fixed obstacles (buildings, vegetation) and moving obstacles (vehicles), target fluctuation, Doppler effect.

Bibliography :
Principes de traitement des signaux radar et sonar - F. LE CHEVALIER - Masson Editeur
Radars - Bases modernes - M. CARPENTIER - Masson Editeur
Physique et théorie du radar - J. DARRICAU - Editions PGI Bagneux
Technique du radar classique - R. BENTEJAC - Masson Editeur
Initiation aux techniques modernes des radars - L. THOUREL - CEPADUES Editions

Requirements :
SRC06-ONDE, SRC06-PROPA and SRC07-ESNL.

Organisation :
Revision of lecture and practical exercise notes. Preparation of the half-day session.

Evaluation :
Two-hour written examination.

Target :

Radar and Sonar Signal Processing	SRC08-TSRS
Number of hours : 26.50 h	2.00 ECTS credit
CM : 16.00 h, TD : 6.00 h, TP : 4.50 h	
Reference Teacher(s) : MERIC STEPHANE	

Objectives :
The importance of the choice of radar signal to reduce uncertainties in the measurement of speed and distance. Measurement techniques (anechoic room). Basics of side-looking airborne radar (SLAR) and sonar systems.

Content :
1. Uncertainties in distance and speed measurements, ambiguity functions in distance and speed, generalised ambiguity function, uncertainty principle. Properties of ambiguity functions associated with the pulse signal with and without frequency shift-keying, finding the ideal radar signal for a given application. Pseudorandom sequence radar and pulse compression radar.
2. Principles of measurement in an anechoic chamber, structure and qualities of anechoic chambers, ultra high frequency absorbers, scalar and vectorial measures, influence of polarisation, Fraunhofer area, measurement of impulse responses, windowing, holographic measurements, localisation of stationary phase centres. Introduction to electromagnetic imaging.
3. Practical half-day : measurements of RCS (Radar Cross Section) in anechoic chamber.
4. Seminar on radar remote sensing separated into two large-scale subjects: (a) physical (propagation, wave-matter interaction, and polarisation) and (b) processing (radar image design, pulse compression and synthetic aperture).
5. Principle of active and passive sonar, notions of submarine acoustics, propagation, reverberation. Characteristics of a sonar signal, carrier noise and transmission environment. Sonar equations.

Bibliography :
""Traitement des images de RSO"" (sous la direction de Henri Maître), Traité IC2, collection Hermès, 2001

Requirements :
SRC06-ONDE, SRC06-PROPA, SRC07-ESNL, SRC07-SYRAD.

Organisation :
Revision of lecture and practical work notes. Preparation of the practical "half-day".

Evaluation :
Two-hour written examination.

Target :

Electronic Students projects	SRC08-PROJ
Number of hours : 20.00 h	2.50 ECTS credit
PR : 20.00 h	
Reference Teacher(s) : LEMOINE CHRISTOPHE	

Objectives :
Realization of the project defined during the first semestria. Achivement of the solutions. demonstrations

Content :
during this semestria, students have to realized what they have proposed during the first semestria (SRC07-CDC):
- test on unitary part
- integration
- analyse of the schedule

For each group, a legacy professor assists them in order to help to find solutions, to give contacts, to analyse the problems, to
propose additionnal tests

Bibliography :
Previous projects, lessons from teachers, internet

Requirements :

Organisation :
home work,

Evaluation :
3 evaluations :
- the report
- the presentation
- the demonstration

students have to give a CD containing all the materials (codes, schemes, references, images, video, reports of tests). All the
projects are saved

Target :

Réseau 2	SRC08-RES
Number of hours : 18.00 h	1.00 ECTS credit
CM : 12.00 h, TP : 6.00 h	
Reference Teacher(s) : UZEL FABIENNE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Digital Communications 2	SRC08-CNUM2
Number of hours : 38.00 h	2.50 ECTS credit
CM : 12.00 h, CM : 8.00 h, TD : 6.00 h, TP : 12.00 h	
Reference Teacher(s) : HELARD MARYLINE	

Objectives :
This second session of digital communications follows the first session SRC07-CNUM1 and deals with digital transmissions over band-limited channels, the design of the associated receivers and taking into account various transmission impairments. Furthermore, the basis techniques in channel coding and multicarrier modulation (OFDM) technics are presented within this session.

Content :
Digital communications (18h de cours, 8 heures de TD)

1. Band limited transmission : intersymbol interference (ISI), Nyquist criterion, eye diagram and constellations, throughput and spectral efficiency.
2. Discrete equivalent channel and various types of channels (Rice, Rayleigh)
3. Receiver optimisation : matched filter concept, optimal receiver, MAP criterion, linear filter receivers. Introduction to equalization.
4. Synchronisation : carrier frequency and sampling frequency recovery. Digital PLL.
5. Digital modulation choice criteria: noise immunity, non linearities, interchannel interferences, multipaths channels, spectral efficiency/Shannon limit

Introduction to channel coding : (10 heures de cours, 2 heures de TD)
Introduction to channel coding. Capacity of a transmission channel. Channel coding theorem.

Bloc codes. Definition. General properties of linear block codes. Generator and parity check matrices. Detection and correction of transmission errors. Minimum distance and performance of bloc codes. Some examples of linear block codes. Cyclic bloc codes. Définition. Some examples. Decoding technics. Error probability of block codes. Performance and coding gain.

Convolutional codes. Main principles of the convolutional codes. Tree, trellis and state diagrams. Decoding of convolutional codes. The Viterbi algorithm. Performance of the convolutional codes. Punctured convolutional codes. Exemples and applications of the convolutional codes.

Introduction to multicarrier modulations (8 heures de cours, 2 heures de TD)
The radio mobile channel. Frequency selectivity and time selectivity. Main principles of multicarrier modulations (Orthogonal Frequency Division multiplex ¿ OFDM). FFT algorithm implementation of OFDM systems. Association to channel coding technics : Coded OFDM. Differential demodulation Channel estimation technics and coherent demodulation. Performance of COFDM systems. Application to Digital Audio Broadcasting (DAB) and to Terrestrial Digital video Broadcasting (DVB-T, DVB-T2).

Bibliography :
S. Beneddeto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions H. Meyr , M. Moeneclaey , "Digital communication receivers, volume 2 : synchronization, channel estimation and signal processing"
J. G. Proakis., "Digital communications", 6th Edition, Mc Graw-Hill Int. Editions, 2003.
Communication systems, S. Haykin, John Wiley & Sons, 2001 Éléments de communications numériques, J. C. Bic, D. Duponteil, J. C. Imbeaux , Dunod. CNET ENST,1987
Communications numériques, A. Glavieux, M. Joindot, Collection pédagogiques des Télécommunications,
S. Beneddeto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions H. Meyr , M. Moeneclaey , "Digital communication receivers, volume 2 : synchronization, channel estimation and signal processing"
J. G. Proakis., "Digital communications", 6th Edition, Mc Graw-Hill Int. Editions, 2003.
Communication systems, S. Haykin, John Wiley & Sons, 2001 Éléments de communications numériques, J. C. Bic, D. Duponteil, J. C. Imbeaux , Dunod. CNET ENST,1987
Communications numériques, A. Glavieux, M. Joindot, Collection pédagogiques des Télécommunications,
Masson, 1996.
Signal et communication numérique. Egalisation et synchronisation, Jean-Marc Brossier, Collection Traitement du signal, Hermès, Paris, 1997.

Requirements :

SRC07-CNUM1 SRC07-SINUM

Organisation :
Study of class content. Practical exercises and lab work.

Evaluation :
2 two-hour written examinations including questions about lab exercises.

Target :

Methods for digital computing	SRC08-MNUM
Number of hours : 26.00 h	1.50 ECTS credit
CM : 12.00 h, TD : 14.00 h	
Reference Teacher(s) :	

Objectives :
"Digital resolution techniques (mathematics). Theoretical basics for modelling, analysis and optimisation problems. Implementation of digital methods with calculators. Algorithm design using the MATLAB language.
"

Content :
"1. Linear regression analysis. Application to radio communications and electronics. Upper rank regression analysis.
2. Polynomial interpolation. Lagrange base. C1 and C2-class cubic spline modelling using Bernstein base. Natural cubic splines. Application to electronics.
3. Mathematical tools for the resolution of non-linear equations. Order of a method. Convergence rapidity.
4. Numeric integration. Lagrange base, quadrature formula order. Rectangle, trapezium methods. Simpson, Gauss-Legendre methods. Application to probability and signal theory (link between analog and digital convolution products). Applications.
5. Digital derivative. Progressive, retrograde, centred differences. Differential equations. Choice of discretisation step. Link with the
Z-transform. Transfer function associated with a discretisation method, stability. Comparison between the results obtained using the bilinear transform and the analog method.
"

"

Bibliography :
"1. J. Rappens, M. Picasso ""Introduction à l'analyse numérique"", Presses polytechniques et universitaires romandes, 1998
2. H. R. Schwartz ""Numerical Analysis - A comprehensive Introduction"", Wiley, 1989
3. H. Urkowitz ""Signal theory and random processes"", Artech House, 1983"

Requirements :
Basic skills in analog and digital processing signals, integral and derivative computing, probabilities.

Organisation :

Evaluation :
Two-hour written examination.

Target :
4SRC

English	HUM08-ANGL
Number of hours : 24.00 h	2.00 ECTS credit
TD : 24.00 h, TD : 24.00 h	
Reference Teacher(s) :	

Objectives :
Acquiring the required skills for working in a firm as an engineer. Reaching the required level (B2) is compulsory in order to graduate.

Content :
-Learning by doing:
The student will have to be able to talk and listen, write documents while showing he/she can solve problems, reason, convince and demonstrate in an articulate manner.
-Expressing oneself accurately and fluently.
The student will engage in activities requiring creative and reactive skills (such as debates, role-plays, individual oral presentations using PowerPoint, projects), which will be based on scientific topics and current events.
-Writing CVs and cover letters
-Scientific English
-Discovering the professional world in an international context
-Preparing for the TOEIC. Furthermore, during the second semester, a specific ¿Toeic Booster¿ course is available for students wishing to attend.

Bibliography :
- Oxford Advanced learners¿ Dictionary
- English Grammar in Use (Cambridge University Press)

Requirements :
1st, 2nd and 3rd year English courses (or equivalent)

Organisation :
Each class lasts two hours and most classrooms are equipped with video and audio. A multimedia language lab and computer rooms are also available and make it possible for the students to work in a stimulating environment. Our teaching resources include press articles, audio and video documents (TV reports, extracts from films and series). We also use the Internet.
Regular personal work is obviously required. The student must be curious and practise English outside the classroom as well.

Evaluation :
TOEIC
15 minute oral exam

Target :

Economy and Management	HUM08-ECO
Number of hours : 10.00 h	1.00 ECTS credit
TD : 10.00 h, TD : 10.00 h	
Reference Teacher(s) : GOURRET FANNY	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Engineer & Society - M1	HUM08-SHES1
Number of hours : 14.00 h	1.00 ECTS credit
TD : 14.00 h, TD : 14.00 h	
Reference Teacher(s) : ECHARD PHILIPPE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Engineer & Society - M2	HUM08-SHES2
Number of hours : 14.00 h	1.00 ECTS credit
CM : 14.00 h, CM : 14.00 h	
Reference Teacher(s) : ECHARD PHILIPPE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Sport and Physical Education	HUM08-EPS
Number of hours : 20.00 h	1.00 ECTS credit
TD : 20.00 h, TD : 20.00 h	
Reference Teacher(s) :	

Objectives :
Team work, discovery of one's capabilities, communication, invention, autonomy, self-discovery and management responsibilities.

Content :
Whole class: "role of the coach, role of the referee, management" (knowledge of the rules, getting involved, leading, decision
making and communicating). Practice and knowledge of the sociomotive roles involved in the strategies of team attack and
team defence. Finding one's place in a group and awareness of your team-mates and their responsibilities.
Organisation of Physical and Sports Education: two 15-hour and one 30-hour sports or physical activity programmes in groups.

Bibliography :
Specialised publications are available at the library. Internet links are posted and updated on the INSA Physical Education website.

Requirements :

Organisation :

Evaluation :
Evaluation is based upon student participation, progress and acquisition. The student is asked to criticise his own progress with respect to the objectives of the course. The ability to be self-critical leads to self-discovery. Sharing this knowledge with a group reinforces one's confidence.

Target :

Work Placement	SRC08-STAGE
Number of hours : 240.00 h	8.00 ECTS credit
ST : 1.00 h	
Reference Teacher(s) : MERIC STEPHANE	

Objectives :
This summer work placement must allow the student to acquire practical experience in a professional environment. The
student will aim to develop his teamwork, communication and observation skills, and improve his capacity to integrate a
business environment.

Content :
- Work placement with agreement (assistant engineer level).
- At least 8 weeks duration.
- In France or abroad.
- Can be carried out in the interim between the 3rd and 4th year or between the 4th and 5th year of studies.

Bibliography :

Requirements :

Organisation :
Writing of a training report.

Evaluation :
The training report is reviewed and evaluated thanks to an assessment form.

Target :

Semestre 9

Parcours Formation Initiale SRC

1	**SRC09-1**		**Communication techniques**	**9.50**
	SRC09-TCCOMP	O	Multicarrier modulations	1.50
	SRC09-TCMIMO	O	MIMO	1.00
	SRC09-TCETA	O	Spread Spectrum Techniques	1.00
	SRC09-TCFIBRES	O	Multicarrier modulations	1.50
	SRC09-TCRECA	O	Channel Equalization	1.50
	SRC09-TCANT	O	Network antennas	1.50
	SRC09-TCCEM	O	Electromagnetic compatibility (EMC). Electromagnetic compatibility (EMC). Electromagnetic compatibility (EMC).	1.50
2	**SRC09-2**		**Networks, digital systems and project**	**8.50**
	SRC09-MOBILE	O	Mobile Networks	1.00
	SRC09-USECASE	O	Use Case in Network Security	1.50
	SRC09-BE	O	Design Office Project and Conferences	3.50
	SRC09-SOPC	O	System on Programmable Chips	1.00
	SRC09-REALTIME	O	Real Time Processing	1.50
3	**SRC09-3**		**Elective modules**	**6.50**
	SRC09-NETLAB	C	Network lab training	2.00
	SRC09-IRHINT	C	Integration and reconfigurability	2.50
	SRC09-LAN-DATA	C	Data Local Network	3.00
	SRC09-IRHPL	C	Deterministic tools for planning and optimizing wireless networks	2.00
	SRC09-IRHPROJ	C	Project	2.00
	SRC09-TCCROSS	C	Cross Layer	1.50
4	**HUM09**		**Non-scientific syllabus S9**	**5.50**
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-PM-A	C	Economics, Law and Business Studies A (Lean six sigma)	2.00
	HUM09-PM-B	C	Economics, Law and Business Studies B (Human Resource Management)	2.00
	HUM09-PM-C	C	Economics, Law and Business Studies C (Human Resources Management)	2.00
	HUM09-PM-D	C	Economics, Law and Business Studies D (MANAGEMENT - ETHICS - RESPONSIBILITY)	2.00
	HUM09-PM-E	C	Economics, Law and Business Studies E (International Strategy and Development)	2.00
	HUM09-PM-F	C	Economics, Law and Business Studies F (sustainable development)	2.00
	EII09-EVST	C	Evaluation stage	1.00
	HUM09-PM-G	C	Economics, Law and Business Studies G (serious game)	2.00
	EII09-HUMT	C	Societal responsibility of business	1.00
	EII09-EVST	C	Evaluation stage	1.00
	INF09-DROIT	C	Legal Training for Engineers	2.00
	SRC09-SPEC	C	Conferences	1.00
	SRC09-CONF	C	SRC09-CONFERENCES	1.00
5	**HUMF1-SAM(DIV)**		**SAM : APES Responsabilités Associatives**	**1.00**
	HUMF1-APES DIV	F	APES Responsabilités associatives à 1 crédit : Mission	1.00

			Diversité	

O = compulsary, C= in choice , F= optional

Multicarrier modulations	SRC09-TCCOMP
Number of hours : 20.00 h	1.50 ECTS credit
CM : 8.00 h, CM : 12.00 h	course taught in English
Reference Teacher(s) : HELARD MARYLINE	

Objectives :
To provide an overview of the channel coding techniques and multicarriers

Content :
Channel coding: Introduction to channel coding. Capacity of a transmission channel,
Shannon's theorem. Presentation of block codes, Galois fields, Cyclic block codes, Convolutional codes

Multi-carriers :
Multicarrier modulations. Characteristics of the radio channel. Principle of multicarrier modulations and their applications to the mobile radio channel. Association of channel coding techniques and multicarrier modulations: COFDM system.
Reception techniques, channel estimation and time and frequency synchronization. COFDM system performance. Implementation of multicarrier modulation in digital audio broadcasting (DAB -Digital Audio Broadcasting and DRM) Digital Television Terrestrial (DVB-T, DVB-T), wireless local area networks (WLAN) access networks (BWA), wireless personal area networks (WPAN), ... multicarrier spread spectrum techniques and their applications in B3G and 4G cellular networks.

Bibliography :
A. Glavieux, "Codage de canal, des bases théoriques aux turbo-codes", Hermès, 2005
B. Vucetic, J. Yuan , "Turbo-codes, principes et applications", Kluwer, 2001
K. Fazel, S. Kaiser "Multi-Carrier ans Spread Spectrum systems", Wiley, 2003

Requirements :
SRC08-CNUM2

Organisation :

Evaluation :
1 hour exam

Target :

MIMO	SRC09-TCMIMO
Number of hours : 16.00 h	1.00 ECTS credit
CM : 16.00 h	
Reference Teacher(s) : HELARD MARYLINE	

Objectives :
To Present multi-antenna techniques and their respective applications.

Content :
MIMO/ Presentation of the different time space schemes: spatial multiplexing, space-time coding, orthogonal and non-orthogonal beamforming. Associated receivers: optimal linear, iterative

Bibliography :

Requirements :

Organisation :

Evaluation :
1 hour exam

Target :

Spread Spectrum Techniques	SRC09-TCETA
Number of hours : 24.00 h	1.00 ECTS credit
CM : 18.00 h, TP : 6.00 h	hand-out in English and course taught in English
Reference Teacher(s) : EL ZEIN GHAIS	

Objectives :
To present the spread spectrum techniques, the multicarrier modulations, the multi-antenna technology and their respective applications.

Content :
Spread spectrum techniques. History of spread spectrum and basic principles.
Direct sequence, frequency hopping, time slots, frequency sweep.
Coding: maximum length codes, Gold codes, Kasami of, Hadamard, Barker codes, JPL.

Synchronisation: acquisition and maintenance of synchronization. Study of performance in the presence of white noise, of jammers. Multiple accesses in a multipath context.

Applications of spread spectrum: Addressing selective division multiple access codes, low interference to other emissions, low probability of intercept, difficulty listening, interference rejection, suppression of multiple discharges, high resolution radiolocation.

Examples of applications:
cellular networks (UMTS), Wireless Local Area Networks son (WiFi, Bluetooth), satellite (Globalstar), radiolocation (GPS), automotive and home automation.

spatial multiplexing, space-time coding orthogonal and non-orthogonal beamforming. Associated receivers: optimal linear, iterative.

Bibliography :
R. C. Dixon, "Spread Spectrum systems", Wiley, 1984

Requirements :
SRC07-CNUM and SRC09-TCEC

Organisation :

Evaluation :
1 hour exam

Target :

Multicarrier modulations	SRC09-TCFIBRES
Number of hours : 20.00 h	1.50 ECTS credit
CM : 20.00 h	
Reference Teacher(s) : HELARD JEAN FRANCOIS	

Objectives :
To provide an overview of the communication using optic fibers

Content :
Technology : multimode step-index and graded index. Guiding mechanism, analysis and definition of the guided modes. Dispersion of multimode fibers. Attenuation of the optical fibers and nonlinear effects.
Transmitters and couplers and the optoelectronic transmission: light emitting diodes and laser diodes.
Receiver : PIN photodiodes and avalanche photodiodes. Direct detection: performance optimization of the preamplifier
Wavelength multiplexing, amplification and optical heterodyne reception, external modulators. Digital transmission over fiber. Optimization of the link: choice of codes and modulation, link budget
Applications : Transmission over fiber telecommunications networks: digital hierarchy, optical fiber network in the international, long distance terrestrial network, the distribution network.

Bibliography :
Les fibres optiques, Notions fondamentales (Câbles, Connectique, Composants, Protocoles, Réseaux...), J.M. MUR

Requirements :
SRC07-CNUM and SRC09-TCCO

Organisation :

Evaluation :
1 hour exam

Target :

Channel Equalization	SRC09-TCRECA
Number of hours : 24.00 h	1.50 ECTS credit
CM : 12.00 h, TD : 6.00 h, TP : 6.00 h	
Reference Teacher(s) : HELARD MARYLINE	

Objectives :
To provide a large overview of receive and equalization techniques

Content :
1. Transmission over frequency selective channel.
2. MAP criterion. Optimal and sub optimal receivers.
3. Adaptive equalization techniques. Different existing algorithms. Adjustment coefficients (LMS, RLS, CMA, ...), main structures and filtering modes and operating phases (acquisition, tracking, blind equalization, sequences learning).
4. Structures and recursive transversal equalizer. Nonlinear equalizer decision feedback (DFE).
5. Advanced Receiver Techniques: iterative reception.
Presentation of many examples.

Bibliography :
J. G. Proakis ,« Digital Communications », ,McGraw-Hill International Editions
B. Widrow, S. D. Stearns, « « Adaptive Signal processing », Prentice Hall International Editions. Signal processing series
S. Benedetto, E. Biglieri, V. Castellani, "Digital transmission theory",Prentice Hall International Editions
S. Haykin, "Adaptive Filter Theory", Prentice Hall International Editions
F. Michaux, « Méthodes adaptatives pour le signal. Outils mathématiques et mise en oeuvre des algorithmes »,Hermès

Requirements :
SRC07-CNUM and SRC07-DESTI

Organisation :
Study of courses and tutorials. Preparation of the practical sessions.

Evaluation :
1 hour exam

Target :

Network antennas	SRC09-TCANT
Number of hours : 28.00 h	1.50 ECTS credit
CM : 14.00 h, TD : 8.00 h, TP : 6.00 h	course taught in English
Reference Teacher(s) : GILLARD RAPHAEL	

Objectives :
To present the principles of antennas' arrays

Content :
Antenna arrays: array factor, uniform linear array and regular phased arrays, planar arrays.
Introduction to synthesis techniques. Coupling in networks. Distribution circuits (application to planar technology).
Introduction to multi-beam antennas and adaptive antennas.

Bibliography :
Antenna theory : analysis and design, C.A. BALANIS, ed. J.Wiley
IMC analysis and computational models, F. TESCHE, M. IANOZ, T. KARLSSON, ed. J. Wiley

Requirements :
SRC08-ANTEN, SRC08-CIRHF

Organisation :
Study courses and literature.
A part of the course is provided with a e-learning platform containing tutorials.

Evaluation :

Target :

Electromagnetic compatibility (EMC). Electromagnetic compatibility (EMC). Electromagnetic compatibility (EMC).	SRC09-TCCEM
Number of hours : 20.00 h	1.50 ECTS credit
CM : 14.00 h, TP : 6.00 h	hand-out in English and course taught in English
Reference Teacher(s) : BESNIER PHILIPPE	

Objectives :
To present the concepts of electromagnetic compatibility (EMC)

Content :
Electromagnetic compatibility (EMC). Physical phenomena related to EMC, electromagnetic coupling modes. Electromagnetic effects on victims (disturbances in conduction and radiation). Ground and masses : design of earth networks, mass signals (analog cards, digital and mixed). Network design mass of an electronic card. European directives, CISPR recommendations, classification, standardized tests, measurements conditions, EMC measures, standards' contents.
Means of protection: electromagnetic shielding, shielding effects and mechanism, conduction protection (filters, limiters, protective components), power protection, ...

Bibliography :

Requirements :

Organisation :

Evaluation :
2 hours exam

Target :

Mobile Networks	SRC09-MOBILE
Number of hours : 12.00 h	1.00 ECTS credit
CM : 8.00 h, TD : 4.00 h	
Reference Teacher(s) : EL ZEIN GHAIS	

Objectives :
Acquisition of the fundamental foundations
of the field of cellular and mobile radio networks
through a description of the main techniques
used and their applications, focusing on the
physical layer of networks

Content :
1. Wireless Networks: history, market development, principle
2. Cellular Concept: frequency reuse, co-channel interference, traffic model, capacity, handover
3. Transmission Techniques (from 1G to 4G):
- 1G (RC2000, NMT, AMPS, TACS, ...)
- 2G (GSM/DCS, IS-95, PDC, D-AMPS, ...)
- 2.5G (GPRS, HSCSD, EDGE, ...)
- 3G (UMTS, cdma2000, IMT-2000, ...)
- 3.5G (HSDPA) - 3.75G (HSUPA)
- 3G++ (HSPA+)
- 3.9G (LTE) - 4G (LTE-Advanced, WiMax, ...)
4. Emerging Technologies: 5G
"

"1. Wireless Networks: history, market development, principle
2. Cellular Concept: frequency reuse, co-channel interference, traffic model, capacity, handover
3. Transmission Techniques (from 1G to 4G):
- 1G (RC2000, NMT, AMPS, TACS, ...)
- 2G (GSM/DCS, IS-95, PDC, D-AMPS, ...)
- 2.5G (GPRS, HSCSD, EDGE, ...)
- 3G (UMTS, cdma2000, IMT-2000, ...)
- 3.5G (HSDPA) - 3.75G (HSUPA)
- 3G++ (HSPA+)
- 3.9G (LTE) - 4G (LTE-Advanced, WiMax, ...)
4. Emerging Technologies: 5G
"

Bibliography :

Requirements :
Network architecture - Radiocommunications

Organisation :

Evaluation :
1-hour written exam

Target :
5th year SRC - Major track, MASTER I-MARS

Use Case in Network Security	SRC09-USECASE
Number of hours : 16.00 h	1.50 ECTS credit
CM : 8.00 h, CM : 8.00 h	
Reference Teacher(s) : AVOINE GILDAS	

Objectives :
Study on additionnal mechanisms in IP network. Part 1 : Security in LAN - IPSEc, attacks, from layer 7 down to layer 2 . Part 2 : use case : which netwrok for which application. Two analyses, one based on IoT, one based on mobile communication 3G/4G

Content :
Part 1 - 8H, review of different security mechanisms and attacks. Part 2 : 2*4H : two scenarios using IoT and mobile network (lessons given by network companies)

Bibliography :

Requirements :
SRC06-RES, SRC08-RES, any network lessons (MAC, IP, TCP, wireless communication)

Organisation :

Evaluation :
2-hour written exam

Target :
5th year SRC - Major track,
Student of the M&N track MASTER I-MARS

Design Office Project and Conferences	SRC09-BE
Number of hours : 49.00 h	3.50 ECTS credit
EP : 48.00 h, PR : 1.00 h	
Reference Teacher(s) : HELARD JEAN FRANCOIS	

Objectives :
Carry out a technical project team and applying concrete scientific methods of project management. Enhance training through technical conferences.

Content :
1. The main objectives of these projects are to carry out scientific work requiring specific organizational efforts. The proposed topics involve reflection, literature and theoretical studies, experimental developments in the form of actions or concrete achievements. Students work in dedicated time slots and have free access to experimental resources including those of the IETR research laboratory "Institute of Electronics and Telecommunications of Rennes
The work of each group leads to a report and to an oral presentation. The idea of these projects relies in putting the students in a situation as close as possible to the industrial reality. They are sometimes carried out in the framework of collaborations with industry.

2. Each year, a number of conferences are offered to students on specific topics. They are provided by external experts from the scientific, industrial and academic world.

Bibliography :
Previous year's design office reports.

Requirements :

Organisation :
This module involves a great deal of personal input.

Evaluation :
3 marks corresponding to the report evaluation, the oral presentation evaluation and the work that has been performed

Target :

System on Programmable Chips	SRC09-SOPC
Number of hours : 10.00 h	1.00 ECTS credit
CM : 4.00 h, TP : 6.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Introduction to embedded systems (technology, management, hardware/software co-design). Case study on a SOPC platform (Altera FPGA).

Content :
Technology of embedded systems: ASIC, FPGA, Study of different reconfigurable circuits (Xilinx, Altera, ...). Introduction to rapid prototyping tools from system to physical level.

Bibliography :

Requirements :
SRC07-LPROG

Organisation :

Evaluation :
Practical training session

Target :

Real Time Processing	SRC09-REALTIME
Number of hours : 16.00 h	1.50 ECTS credit
CM : 10.00 h, TP : 6.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Study of real time operating systems and application examples.

Content :
Various fields of applications, embedded systems, kernel architecture, Kernel services (tasks, synchronizations, communications), multi-processes/multi-processors programming, scheduling policies, memory management.

Applications: embedded systems for signal processing (telecommunication, image / video) in automotive, avionics, etc. ....
Systems with strong real time constraints, system management / supervision.

Practical work on MicroC-OSII.

Bibliography :

Requirements :

Organisation :

Evaluation :
2 hours exam

Target :

Network lab training	SRC09-NETLAB
Number of hours : 24.00 h	2.00 ECTS credit
PR : 24.00 h	hand-out in English and course taught in English
Reference Teacher(s) : UZEL FABIENNE	

Objectives :
Build a real network, including VLAN, VPN, routing protocols and Qos services. This project will illustrate layers 1 up to layers 4.

Content :
In the first step, students will simulate the network using Packet tracer software. In this architecture, they will observe the influences of VLAn VPN strategies.
In the 2nd step, they will use equipments in order to build their real network. Typical equipment¿s are : CISCO (wired and wireless), LINKSYS, DLINK, ¿They will anlayse the traffic, the data rate, filter the messages (thanks to wireshark for example).

Bibliography :

Requirements :
SRC09-TCRC and SRC09-WIRED

Organisation :
labs= 24 hours

Evaluation :
course mark

Target :

Integration and reconfigurability	SRC09-IRHINT
Number of hours : 26.00 h	2.50 ECTS credit
CM : 18.00 h, TD : 8.00 h	hand-out in English and course taught in English
Reference Teacher(s) : FOURN ERWAN	

Objectives :
To study the concepts of microwave circuits and systems

Content :
Presentation of the technologies that are used in integrated radio front-ends (MMICs, MEMS, printed antennas, Systems in Package SiP-, ...);
study of architectures and topologies used in reconfigurable devices ("smart antennas" , reconfigurable active networks, ...)

Bibliography :

Requirements :
SRC08-CIRHF, SRC08-ANTEN, SRC05-PRER, SRC08-SYRAD

Organisation :

Evaluation :
1 hour exam

Target :

Data Local Network	SRC09-LAN-DATA
Number of hours : 24.00 h	3.00 ECTS credit
CM : 10.00 h, CM : 10.00 h, TD : 2.00 h, TD : 2.00 h	
Reference Teacher(s) : UZEL FABIENNE	

Objectives :
2 parts : one on IPV6 and WLAN, one on WPAN based on IP

Content :
"Partie 1- 8H : Network administration, ipv6, inter-as routing . Partie 2- 8H- Introduction of some of wireless network using IP(bluetooth, wifi, wlan, wimax, ..)

"

Bibliography :

Requirements :
network, IP V4

Organisation :

Evaluation :
2-hour written exam

Target :
5th year SRC - Optional track "network design", Student of the M&N track MASTER I-MARS

Deterministic tools for planning and optimizing wireless networks	SRC09-IRHPL
Number of hours : 16.00 h	2.00 ECTS credit
CM : 16.00 h	hand-out in English and course taught in English
Reference Teacher(s) : MERIC STEPHANE	

Objectives :
The main objective of this lecture is to present the theoretical tools describing the diffraction phenomena. These descriptions make possible to establish the deterministic radio channel response. Thus, this lecture is useful to get a basic background to understand the planning and optimizing wireless network tools.

Content :
Radio planning tools (deterministic model of the propagation channel), propagation prediction in urban areas by using the concepts of diffraction and scattering of electromagnetic waves on buildings, Analysis methods related to physical optics (assumptions of PO, limitations of PO, stationnary phase formulation), to geometrical optics (`formulation of Sommerfeld-Runge, reflection and refraction rays, ray-tracing method), the geometrical theory of diffraction (edges and discontinuities) and the uniform theory of diffraction (surface diffraction and creeping waves).

Bibliography :

Requirements :
SRC08-CIRHF, SRC08-ANTEN, SRC05-PRER, SRC08-SYRAD

Organisation :

Evaluation :
1 hour exam

Target :

Project	SRC09-IRHPROJ
Number of hours : 24.00 h	2.00 ECTS credit
PR : 24.00 h	hand-out in English and course taught in English
Reference Teacher(s) : FOURN ERWAN	

Objectives :
Study the concepts of circuits and microwave subsystems on radio planning techniques. Become familiar with corresponding characterization and design tools.

Content :
Design of a head RF transceiver (power amplifier, mixer, filter, ...). Simulation using commercial tools circuits, antennas and systems (Agilent ADS and Momentum, HFSS, ...) additional metrology on network analyzers.

Bibliography :

Requirements :
SRC08-CIRHF, SRC08-ANTEN, SRC05-PRER, SRC08-SYRAD

Organisation :

Evaluation :
Project evaluation

Target :

Cross Layer	SRC09-TCCROSS
Number of hours : 10.00 h	1.50 ECTS credit
CM : 10.00 h	hand-out in English and course taught in English
Reference Teacher(s) : MARY PHILIPPE	

Objectives :
Introduce new ways to optimize the wireless communication systems by studying the dependence between layers in the OSI model. The course focuses on the lowest layers, i.e. PHY, MAC and Network.

Content :
1 - Remind on the different layers of the OSI and TCP / IP models. Relevant criteria for the conception of PHY / MAC layers.
2 - Capacity region, achievable data rate.
3 - Convex optimization tools for resource allocation problems in wireless communications: water-filling, best user scheduling.
4 - MAC / Link spectral efficiency ; packet error rate.
5 - Cross-layer conception criteria: instantaneous delay, average delay, jitter.
6 - Impact of non-reliable radio links on the network graph connectivity.
7 - A cautionary approach of cross-layer design.

Bibliography :
Ana I. Pérez-Neira, Marc Realp Campalans, "Cross-layer Resource Allocation in Wireless Communications", Elsevier.

Marvin K. Simon, Mohamed Slim-Alouini, "Digital Communication Over Fading Channels", Wiley.
David Tse, Pramod Viswanath, "Fundamentals of Wireless Communications".

Requirements :
The courses : TCM05-MATHS (Probability), SRC06 - TTSAA, SRC07 - DESTI, SRC07-CNUM1 and 2, SRC08 - basics of network, SRC08 - Radiocom.

Organisation :
Lectures of 2 hours with exercises.

Evaluation :
2 hours exam.

Target :

English S9 Conversation	HUM09-ANGL-CONV
Number of hours : 10.00 h	1.50 ECTS credit
TD : 10.00 h, TD : 10.00 h	
Reference Teacher(s) : LE VOT PHILIPPE	

Objectives :
- Improving communication skills in everyday life situations as well as in a professional or social context.
- Obtaining or reinforcing C1 level, strongly advised/recommended by the CTI. t.

Content :
- Learning by doing: students will have to be able to speak and listen, write a document while showing they can solve problems, reason, convince and demonstrate in an articulate manner.
- Expressing oneself accurately and fluently: students will engage in activities requiring creative and reactive skills such as debates, role-plays, individual oral Power Point presentations, projects, based on scientific topics and current events.

Bibliography :
1. English Grammar in Use (Cambridge University Press)
2. Dictionnaire Collins Cobuild
3. Polycopié de l' INSA

Requirements :
Having taken and passed the TOEIC test during the previous two years (800 required)
or any other B2 certification recognized by the CTI.

Organisation :
- Each class lasts one hour and most classrooms are equipped with video and audio. A multimedia lab and computer rooms are also available for the students to work in a stimulating environment.
- Teaching resources include press articles, audio and video documents (TV reports, extracts from films and series) as well as the Internet.

Evaluation :
Continuous assessment: The final mark (out of 20) will be based on the attendance rate and the personal implication of the student during the class.

Target :

TOEIC 5th year	HUM09-ANGL-TOEIC
Number of hours : 20.00 h	1.50 ECTS credit
TD : 20.00 h, TD : 20.00 h	
Reference Teacher(s) : LE VOT PHILIPPE	

Objectives :
- Improving communication skills in everyday life situations as well as in company and business context.
- Obtaining or reinforcing the B2 level requested by the CTI.
- Obtaining 800 score at the final TOEIC test.

Content :
Learning by doing : students will have to be able to speak and listen, write a document while showing they can solve problems, reason, convince and demonstrate in an articulate manner.
Expressing oneself accurately and fluently : students will engage in activities requiring creative and reactive skills such as debates, role-plays, individual oral Power Point presentations, projects, based on scientific topics and current events.

Bibliography :
- English grammar in Use, Intermediate Edition (CUP)
- Robert and Collins bilingual dictionary or Collins Cobuild

Requirements :
Not having already taken and passed the TOEIC test during the previous two years
B1/B2 level advised

Organisation :
Each class lasts two hours and most classrooms are equipped with video and audio. A multimedia lab and computer rooms are also available for the students to work in a stimulating environment.
Teaching resources include press articles, audio and video documents (TV reports, extracts from films and series) as well as the Internet. B2 level tests are also taken throughout the course.

Evaluation :
Final mark based on :
TOEIC score at final exam + attendance (more than 4 non justified absences result in 0/20 mark).

Target :
5th year students who haven't already passed their TOEIC

Economics, Law and Business Studies A (Lean six sigma)	HUM09-PM-A
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
* Lean Six Sigma (28h / in French)
Lean Six Sigma is a methodology that enables firms to make their processes more effective and efficient. It¿s the current industry standard for process improvement designed to reduce waste and enhance output quality.

* Law (8h / in French)
Main principles of the French legal system

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies B (Human Resource Management)	HUM09-PM-B
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field)
- Understanding the importance of teamwork: making collective decisions and producing the expected work in time

Content :
* Human Resource Management (20h / in French)
    - Main current challenges of Human Resource Management
    - Human Resource Management¿s tools and organization
    - Focus on how team managers deal with Human Resource Management

* Law (8h / in French)
    Main principles of the French legal system

* Social legislation (8h / in French)
    Main principles of French social legislation
    Employment contract

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies C (Human Resources Management)	HUM09-PM-C
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field)
- Understanding the importance of teamwork: making collective decisions and producing the expected work in time

Content :
* Human Resource Management (20h / in French)
    - Main current challenges of Human Resource Management
    - Human Resource Management¿s tools and organization
    - Focus on how team managers deal with Human Resource Management

* Law (8h / in French)
    Main principles of the French legal system

* Social legislation (8h / in French)
    Main principles of French social legislation
    Employment contract

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies D (MANAGEMENT - ETHICS - RESPONSIBILITY)	HUM09-PM-D
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : GOURRET FANNY	

Objectives :
This course aims at enabling students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
The program's main objective is to provide a multidisciplinary approach to the field of innovation, strategy and industrial design. This course will give an overview of the innovative process.
During this program, participants will have the opportunity to explore a business case covering the first stage of a product development project.

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - S7 and S8

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies E (International Strategy and Development)	HUM09-PM-E
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : GOURRET FANNY	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time.

Content :
This course provides students with the tools necessary to understand and work effectively in today's international economic environment. It explores how innovative firms address new markets and compete outside their national frontiers. The course focuses on strategic choices regarding effective actions in international business.

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advice to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies F (sustainable development)	HUM09-PM-F
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
- Project Management (28 h / in French)
    - Efficient Project Management tools and organization according to PMI (Project Management Institute)
    - Agility
    - SCRUM

- Law (8 h / in French)
    Main principles of the French legal system

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advice to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Evaluation stage	EII09-EVST
Number of hours : 5.00 h	1.00 ECTS credit
EP : 1.00 h, EP : 1.00 h, TA : 4.00 h, TA : 4.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Economics, Law and Business Studies G (serious game)	HUM09-PM-G
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	course taught in English
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
-Establishing a strong, specific vocabulary base
-Understanding the main issues that industrial companies deal with (in a specific management field).
-Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
* Business Simulation (serious game) (28h / in English)
The business simulation ¿Global Challenge¿ (a CESIM product) has been designed to improve the understanding and knowledge of the complexity of global business operations in a dynamic, competitive environment. It focuses on strategic management, international management and business policy.
The task for the student teams is to manage a global mobile telecommunications company as its technology and markets evolve. Students will develop and execute strategies for their simulated company operating in the USA, Asia, and Europe.
The simulation is based on an online platform that allows students to play in their own language (many languages available: English, Spanish, Portuguese, Chinese,¿).

* Law (8h / in French)
Main principles of the French legal system

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Societal responsibility of business	EII09-HUMT
Number of hours : 20.00 h	1.00 ECTS credit
CM : 20.00 h, CM : 20.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Evaluation stage	EII09-EVST
Number of hours : 5.00 h	1.00 ECTS credit
EP : 1.00 h, EP : 1.00 h, TA : 4.00 h, TA : 4.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Legal Training for Engineers	INF09-DROIT
Number of hours : 20.00 h	2.00 ECTS credit
CM : 20.00 h, CM : 20.00 h	
Reference Teacher(s) :	

Objectives :
To give to final-year engineers, whether or not in project manager positions, the key legal concepts for understanding the protection of intellectual creations and software, the contractual mechanisms for producing software content, and the terms of software licenses.

Content :
5 independent modules CM1 to CM5

CM1: COMPUTER CREATIONS AND ACTORS

CM 2: GENERIC CONTRACTUAL STRUCTURES AND RESPONSIBILITIES

CM 3: SPECIFIC CONTRACTUAL STRUCTURES

CM 4: SOFTWARE LICENSES (INCLUDING GPL)

CM 5: CREATION AND ADMINISTRATION OF WEB SITES

Bibliography :
On the internet : http://www.legalis.net/

Books : Informatique, T_l_coms, Internet - Ed Francis Lefebvre 2012

Requirements :
passing the introductory module to general law (8H Lectures)

Organisation :
Lectures (7 x 2H)

Evaluation :
final exam

Target :

Conferences	SRC09-SPEC
Number of hours : 16.00 h	1.00 ECTS credit
CM : 16.00 h, CM : 16.00 h	
Reference Teacher(s) :	

Objectives :
Teaching students the fundamentals of Project Management and practice within specific projects.

Content :
Project's Organization
Planning, analysis and formalization of individual and team goals.
Methodological tools for project management
Analysis of deviations from the specifications
Risk Management
All the concepts covered in this course will be applied to a specific case study within dedicated projects (SRC09 TCBE
module).

Bibliography :

Requirements :

Organisation :

Evaluation :
Oral defense of the project (Implementation of the lecture's concepts)

Target :

SRC09-CONFERENCES	SRC09-CONF
Number of hours : 16.00 h	1.00 ECTS credit
CM : 16.00 h, CM : 16.00 h	
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Industrial or academic experts in various domains present small talks (typically 2h) about technical and scientific issues in their domain. The main idea is to open students to the world of industry and research and make them sensitive to state of the art issues.

Content :
The talks may vary depending on the availability of experts

Bibliography :

Requirements :

Organisation :

Evaluation :
PASS if every session is attended, FAIL otherwise.

Target :
5SRC and 5M&N

APES Responsabilités associatives à 1 crédit : Mission Diversité	HUMF1-APES DIV
Number of hours : 60.00 h	1.00 ECTS credit
DIV : 7.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

INSA RENNES - Systèmes et Réseaux de Communications (SRC) : 2020/2021

Semestre 9

Parcours Média & Networks

1	**M&N09-SEIR**		**Embedded systems - Media - Networks**	**17.50**
	EII09-CONSO	C	Energy consumption in embedded systems	1.00
	EII09-DISPS	C	Digital Signal Processor	2.00
	EII09-PPEM	C	Parallel Programming for Embedded MPSoCs	2.50
	EII09-AHD	C	Advanced Hardware Design	1.00
	EII09-SYSC	C	SystemC	1.00
	SRC09-SOPC	C	System on Programmable Chips	1.00
	SRC09-REALTIME	C	Real Time Processing	1.50
	SRC09-SYSLAB	C	Digital Systems Lab	2.00
	EII09-COTR	C	Video Compression and Transcoding	3.00
	EII09-VIS	C	Computer Vision	2.00
	EII09-ANIM	C	Image Analysis II	2.00
	SRC09-PRCNUM	C	Digital Communications prerequisites	1.50
	SRC09-NETLAB	C	Network lab training	2.00
	SRC09-USECASE	C	Use Case in Network Security	1.50
	SRC09-LAN-DATA	C	Data Local Network	3.00
	SRC09-MOBILE	C	Mobile Networks	1.00
2	**M&N09-Projet**		**Technical Project**	**8.00**
	M&N09-PROJ	O	Technical project	8.00
3	**HUM09-M&N SRC**		**ENSEIGNEMENTS D'HUMANITE - M&N09**	**4.50**
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-PM-A	C	Economics, Law and Business Studies A (Lean six sigma)	2.00
	HUM09-PM-B	C	Economics, Law and Business Studies B (Human Resource Management)	2.00
	HUM09-PM-C	C	Economics, Law and Business Studies C (Human Resources Management)	2.00
	HUM09-PM-D	C	Economics, Law and Business Studies D (MANAGEMENT - ETHICS - RESPONSIBILITY)	2.00
	HUM09-PM-E	C	Economics, Law and Business Studies E (International Strategy and Development)	2.00
	HUM09-PM-F	C	Economics, Law and Business Studies F (sustainable development)	2.00
	SRC09-CONF	C	SRC09-CONFERENCES	1.00
4	**HUMF1-SAM(DIV)**		**SAM : APES Responsabilités Associatives**	**1.00**
	HUMF1-APES DIV	F	APES Responsabilités associatives à 1 crédit : Mission Diversité	1.00

O = compulsary, C= in choice , F= optional

Energy consumption in embedded systems	EII09-CONSO
Number of hours : 16.00 h	1.00 ECTS credit
CM : 8.00 h, TP : 8.00 h	
Reference Teacher(s) : MENARD DANIEL	

Objectives :
Energy consumption is a major challenge for electronic systems. For autonomous systems, managing energy consumption is essential to extend the autonomy or the system lifetime. Moreover, the significant increase of embedded electronic systems implies to reduce the energy optimization in order to limit the overall electricity consumption. The goal of this course is to manage and to optimize the energy consumption of embedded digital systems.

Content :
1. Introduction

2. Energy Consumption Modeling
    2.1 Transistor models
    2.2 Dynamic energy
    2.3 Static energy

3. Energy consumption reduction
    3.1 Dynamic energy reduction
    3.2 Static energy reduction

4. Low power & energy System design
    4.1 Power & energy estimation
    4.2 Hardware design
    4.3 Software design

Bibliography :
Low-Power Electronics Design, C. Piguet, CRC Press, 2004

Requirements :
EII08-LP -Programmable Logic Devices
EII08-SEE -Embedded Operating Systems
EII07-ARC -Computer Architectures 2

Organisation :
- Courses given by internal and external professors
- Practical work are based on managing energy and power consumption on embedded multi-core platform with Linux OS. The targeted platform is a Heterogeneous Multi-Processing (HMP) Octa Core Linux Computer (Odroid Exynos XU3).

Evaluation :
Practical work and project grading.

Target :
5EII, M&N students

Digital Signal Processor	EII09-DISPS
Number of hours : 24.00 h	2.00 ECTS credit
CM : 10.00 h, TP : 14.00 h	
Reference Teacher(s) : MENARD DANIEL	

Objectives :
More and more embedded applications integrate Digital Signal Processing to deliver innovative features. The goal of this course is to master the implementation of digital signal processing applications on single-core fixed-point DSPs

Targeted main competences are:
- Develop C code for digital signal processing applications
- Optimize code for low power DSPs
- Optimize code for high performance DSPs
- Fixed-point conversion of digital signal processing systems

Content :
- Models for DSP applications
- Architecture of low power DSPs
- Architecture of high performance DSPs
- Fixed-point arithmetic
- Fixed-point conversion (dynamic range evaluation, fixed-point coding, numerical accuracy evaluation)

Bibliography :
[1] MADISETTI V., "VLSI Digital Signal Processors", IEEE Press, 1995;
[2] LAPSLEY P. & al., "DSP Processor Fundamentals", IEEE Press, 1995;
[3] BAUDOUIN G. & VIROLLEAU F., "DSP : les processeurs de traitement du signal", Dunod, 1996.

Requirements :
EII07-ARC : Computer Architecture 2;
EII07-TSAN : Signal processing and Digital automatic

Organisation :
Pedagogy based on project.

Evaluation :
Exam 2h

Target :
5EII and 5M&N

Parallel Programming for Embedded MPSoCs	EII09-PPEM
Number of hours : 30.00 h	2.50 ECTS credit
CM : 8.00 h, PR : 10.00 h, TP : 12.00 h	
Reference Teacher(s) : DESNOS KAROL	

Objectives :
For many years, following the ever-increasing number of transistors per chip, advances in computer architecture mostly consisted of adding complex mechanisms to mono-core processors to improve their computing performance. In the last decade, the continuous growth of computing performance was supported by the introduction of multi-core architectures, first for high-performance computing, then in mainstream desktop CPUs, and now in smartphones and embedded systems.

Embedded systems implementing modern applications such as telecommunication standard 3GPP Long Term Evolution (LTE) and video compression standard MPEG High Efficiency Video Coding (HEVC) require high execution speed, low power consumption and run-time adaptivity.

Adaptivity, memory limitation and load balancing between cores are hard to obtain. This course intends to give an overview of distributed high performance solutions and of the new challenges brought by latest applications and Multiprocessors Systems-on-Chips (MPSoCs) architectures such as the 8-core Texas Instruments TMS320C6678 or the 256-core Kalray MPPA. Solutions for programming such architectures will be discussed.

Targeted competences are:
- To understand internal mechanisms of multicore MPSoCs
- To program multi-core architectures using pthread, OpenMP, and Preesm
- To choose a multicore programming method while understanding its limitations
- To design a high performance embedded systems using available resources efficiently

Content :
Content:
- Models of Computation
- Multicore Architectures
- Architecture Models
- Assignment and Ordering Problem
- Multicore Programming Tools

Bibliography :
J Karam, I. AlKamal, A. Gatherer, G. A Frantz, D. V Anderson, and B. L Evans, "Trends in multicore DSP platforms, IEEE SPM, 2009
Hae-woo Park, Hyunok Oh, and Soonhoi Ha, "Multiprocessor SoC Design Methods and Tools", IEEE SPM, 2009
S. Sriram, S. S. Bhattacharyya, "Embedded Multiprocessors : Scheduling and Synchronization - Second Edition", CRC Press, 2009
M. Pelcat, S. Aridhi, J. Piat, J-F. Nezan, "Physical Layer Multicore Prototyping: A Dataflow-Based Approach for LTE eNodeB", Springer, 2012

Requirements :
Computer Architecture I & II (EII05-ARC, EII07-ARC), C Language (ESM05-INFOC).

Organisation :
- Courses given by internal and external professors
- Practical work and project are based on pthread, OpenMP, and the dataflow-based programming.
- Target architectures are multicore x86 processors and the TMS320C6678 multi-DSP evaluation board
- The goal of practical work is for students to acquire competences for programming the platform
- The project aims at giving students some programming habits

Evaluation :
Practical work and project grading.

Target :
5EII and 5 M&N

Advanced Hardware Design	EII09-AHD
Number of hours : 12.00 h	1.00 ECTS credit
CM : 4.00 h, PR : 8.00 h	hand-out in English and course taught in English
Reference Teacher(s) : DARDAILLON MICKAEL	

Objectives :
- Advanced hardware design method for complex digital systems
- Study and implementation of a complete design flow, from high-level description to hardware implementation

Targeted main competences are:
-Efficient use of available ressources pour design a numeric system
-Use of an high-level synthesis tool

Content :
-C language for high-level synthesis, design and optimisation
-Test and validation: verification methodology, automatic verification, testbed implementation
-Design, synthesis and verification of a system using Vivado HLS

Bibliography :
R. Kastner, J. Matai, and S. Neuendorffer, Parallel Programming for FPGAs. 2018.
http://kastner.ucsd.edu/hlsbook

Requirements :
- Programmable Logic
- C Language

Organisation :

Evaluation :
-Attendance at lectures and lab sessions
-Lab report

Target :
5EII, M&N

SystemC	EII09-SYSC
Number of hours : 14.00 h	1.00 ECTS credit
CM : 8.00 h, TP : 6.00 h	
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
This lecture aims at presenting the System Design languages (SystemC) for complex system designing. Special emphasis will be given on modelling across different levels of abstraction from untimed via timed transaction level models down to register transfer models including the needed refinement steps.

Content :
1. Requirements for a system methodology in order to design a system. Overview of existing methodologies
2. Presentation of the System C language syntax. :
-Programming environment.
-Concepts of module, port, channel, interface.
Channels, ports, interfaces, Module constructor
Events, Event queue
Thread processes, Method processes
Module instantiation (in modules)
3. Simulation of complex systems with System C.
4. Labs on a transmission system. Simulation of the system and implementation on an embedded SOC.

Bibliography :

Requirements :

Organisation :

Evaluation :
1 hour exam

Target :
5EII, M&N

System on Programmable Chips	SRC09-SOPC
Number of hours : 10.00 h	1.00 ECTS credit
CM : 4.00 h, TP : 6.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Introduction to embedded systems (technology, management, hardware/software co-design). Case study on a SOPC platform (Altera FPGA).

Content :
Technology of embedded systems: ASIC, FPGA, Study of different reconfigurable circuits (Xilinx, Altera, ...). Introduction to rapid prototyping tools from system to physical level.

Bibliography :

Requirements :
SRC07-LPROG

Organisation :

Evaluation :
Practical training session

Target :

Real Time Processing	SRC09-REALTIME
Number of hours : 16.00 h	1.50 ECTS credit
CM : 10.00 h, TP : 6.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Study of real time operating systems and application examples.

Content :
Various fields of applications, embedded systems, kernel architecture, Kernel services (tasks, synchronizations, communications), multi-processes/multi-processors programming, scheduling policies, memory management.

Applications: embedded systems for signal processing (telecommunication, image / video) in automotive, avionics, etc. ....
Systems with strong real time constraints, system management / supervision.

Practical work on MicroC-OSII.

Bibliography :

Requirements :

Organisation :

Evaluation :
2 hours exam

Target :

Digital Systems Lab	SRC09-SYSLAB
Number of hours : 24.00 h	2.00 ECTS credit
TD : 24.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
The role of this project is to apply all the concepts of Digital Design on a real application.

Content :
This 24 hours project aims to implement all the concepts learned in the SRC09-MOCNVHD and SRC09-SYSC module.
It starts with a SystemC modeling of a complex digital communication circuit (software and hardware blocks) for system simulation and platform sizing.
It ends up with the implementation of the circuit onto a real FPGA platform composed of software and hardware parts.

Bibliography :

Requirements :

Organisation :

Evaluation :
Project evaluation

Target :

Video Compression and Transcoding	EII09-COTR
Number of hours : 39.00 h	3.00 ECTS credit
CM : 15.00 h, TP : 24.00 h	
Reference Teacher(s) : MORIN LUCE, ZHANG LU	

Objectives :
This lecture aims at presenting fundamental and advanced methods dedicated
to image and video compression.
An overview of Audio/Video Standards and Codecs most commonly used in industry is presented.
Practical work is done using didactic softwares (ImageINSA VCdemo), programming
classcal algorithms (in C and Matlab) and running classical codecs through opensource APIs
allowing to analyse and transcode Audio/Video files (ffmpeg, directshow, mediaInfo).

Targeted skills are:
-> To know image and video coding principles and methods
-> To understand and build a coding scheme described as a block diagram
-> To translate state-of-the-art algorithms into C or Matlab code
-> To master parameter setting of encoders
-> To transcode a video

Content :
1. Transcoding of audio-visual contents : use-cases, codec, quality, containers
2. Introduction to image coding: entropy coding, PCM, DPCM, transform coding
3. Still image standards: JPEG, JPEG-LS, JPEG 2000
4. Video compression principles : motion estimation, motion compensation
5. Standard video codecs: MPEG-2, MPEG-4, AVC, SVC, HEVC
6. Conferences by industrial partners ; conferences may vary each year
examples :
- Standardization, Pierrick Philippe, Orange Labs
- Quality asssment for video coding, Jérome Fournier, Orange Labs

Bibliography :
-http://www.fourcc.org
-http://support.microsoft.com/kb/294880
-http://mpeg.chiariglione.org/
-http://en.wikipedia.org/wiki/Comparison_of_container_formats
-T. Ebrahimi, C. Christopoulos, "JPEG 2000 The next generation still image coding system", EUSIPCO'00, 2000
-Gregory K. Wallace, "The JPEG Still Picture Compression Standard" , IEEE Transactions on Consumer Electronics, Vol.38, No. 1, Février 1992
-Bernd Girod, "Image and Video Compression", lecture notes, Standford University, 2005
-Ian E Richardson, "H.264 and MPEG-4 Video Compression", John Wiley ed., 2003
-Vector Quantization and Signal Compression, Allen Gersho, Robert M. Gray, Springer, 1992 - Computers

Requirements :
Digital signal processing and automation (EII07-TSAN).
Image processing (EII08-AI)
Mathematical programming (EII08-OM)

Organisation :
- Revision of lecture notes. Preparation of practical works.
- Labs on transcoding with Visual Studio (C++, C#), ffmpeg, directshow, mediaInfo.
- Labs on compression with ImageINSA and VCDemo softwares, implementation of coding algorithms in C and Matlab.

Evaluation :
Attendence,
Lab evaluation,
Written examination.

Target :
5EII and 5M&N students

Computer Vision	EII09-VIS
Number of hours : 26.00 h	2.00 ECTS credit
CM : 12.00 h, TD : 2.00 h, TP : 12.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PRESSIGOUT MURIEL	

Objectives :
This course is an introduction to computer vision techniques with a single camera or with several ones. Estimation processes used in computer vision are also studied.

The targeted skills are :
-> Solve a pose computation problem by using a Gauss-Newton minimization
-> Compute a depth map from stereoscopic images using the epipolar geometry properties
-> Estimate a 2D tranformation using a RANSAC algorithm

Content :
1. Monocular vision geometry (perspective projection, calibration and pose estimation)
2. Sterevision : 3D reconstruction, epipolar geometry, 2D homography, autocalibration

Pratical exercises are in C++ language.

Bibliography :
1. HORAUD R., MONGA O., ""Vision par ordinateur"", Hermès, 1993.
2. AYACHE N., ""Vision stéréoscopique et perception multi-sensorielle"", Inter-Ed. Science Info, 1988.
3. HARTLEY R., ZISSERMAN A., "Multiple View Geometry in Computer Vision", Second Edition, Cambridge University Press, March 2004.

Requirements :
Optimization (EII08-OM) and object oriented programming (EII07-POO).

Organisation :
Revision of lecture notes. Preparation of labs.

Evaluation :
Two-hour written examination (no documents) at the end of the semester.

Target :
5EII, Media and Networks semester

Image Analysis II	EII09-ANIM
Number of hours : 20.00 h	2.00 ECTS credit
CM : 8.00 h, TP : 12.00 h	
Reference Teacher(s) : ZHANG LU	

Objectives :
Given the measurement signals from the real world, how can the needed information be inferred? In other words, how should the measurements from a sensory system be processed in order to bring maximum information in an explicit and usable form ? This is the main topic of this course - the same problem dealed with by the classification and the estimation. The state estimation (such as the Markov model) is out of the scope of the course.

Content :
1. Detection and classification
2. Parameter Estimation
3. Supervised Learning
4. Non-supervised Learning

Bibliography :
[1] Bangjun Lei, Guangzhu Xu, Ming Feng, Yaobin Zou, Ferdinand Van Der Heijden, Dick De Ridder and David M.J.Tax, "Classification, parameter estimation and state estimation : an engineering approach using MatLab", Second Edition, Wiley, 2017.
[2] R.O. Duda, P.E. Hart and D.G. Stork, "Pattern Classification", John Wiley & Sons, Ltd, London, UK, 2001.
[3] S.M. Kay, "Fundamentals of Statistical Signal Processing - Estimation Theory", Prentice Hall, New Jersey, 1994.

Requirements :
Mathematics (ESM05-ANAL, ESM05-PROBA), Signal processing and Digital automatic(EII07-TSAN), Numérical methods (EII07-MN)

Organisation :
Revision of lecture notes. Preparation of exercises and practical work.

Evaluation :
Course attendance and Project

Target :
5EII ad 5M&N

Digital Communications prerequisites	SRC09-PRCNUM
Number of hours : 16.00 h	1.50 ECTS credit
CM : 16.00 h	hand-out in English and course taught in English
Reference Teacher(s) : HELARD JEAN FRANCOIS	

Objectives :
To deal with the basis digital communication techniques as channel coding, multicarrier modulations and single carrier transmissions on limited bandwidth channel.

Content :
1. Model of a digital communication system
2. Basis channel coding techniques
Block codes and cyclic block codes. Codes construction. Decoding techniques. Performance and channel coding gain.
Convolutional codes. Representation and main principles. Decoding techniques. Performance and main applications.
3. Single carrier transmission over unlimited and limited bandwidth channels. Nyquist criterion. Equalization techniques.
4. Multicarrier modulations. Frequency and time selectivity of the radio-mobile channel. Multicarrier modulation principle (OFDM). Digital implementation of OFDM with Fast Fourier Transform Demodulation and performance. Applications to broadcast and telecommunication systems.

Bibliography :
M. Joindot, A. Glavieux, "Introductions aux communications numériques", Ed. Dunod,
S. Beneddeto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions,
J. G. Proakis., "Digital communications", 6th Edition, Mc Graw-Hill Int. Editions, 2003,
C. Berrou, « Codes et turbocodes », collection IRIS, Springer,
K. Fazel, S. Kaiser, « Multi-Carrier and spread spectrum systems, Wiley.

Requirements :
Modules SRC05-PRER, SRC06-TSIA, SRC07-DESTI, SRC07-SINUM

Organisation :
Courses documents

Evaluation :
Un contrôle continu (Cours, Td, TP)
1 Devoir surveillé de 1 heure.

Target :

Network lab training	SRC09-NETLAB
Number of hours : 24.00 h	2.00 ECTS credit
PR : 24.00 h	hand-out in English and course taught in English
Reference Teacher(s) : UZEL FABIENNE	

Objectives :
Build a real network, including VLAN, VPN, routing protocols and Qos services. This project will illustrate layers 1 up to layers 4.

Content :
In the first step, students will simulate the network using Packet tracer software. In this architecture, they will observe the influences of VLAn VPN strategies.
In the 2nd step, they will use equipments in order to build their real network. Typical equipment¿s are : CISCO (wired and wireless), LINKSYS, DLINK, ¿They will anlayse the traffic, the data rate, filter the messages (thanks to wireshark for example).

Bibliography :

Requirements :
SRC09-TCRC and SRC09-WIRED

Organisation :
labs= 24 hours

Evaluation :
course mark

Target :

Use Case in Network Security	SRC09-USECASE
Number of hours : 16.00 h	1.50 ECTS credit
CM : 8.00 h, CM : 8.00 h	
Reference Teacher(s) : AVOINE GILDAS	

Objectives :
Study on additionnal mechanisms in IP network. Part 1 : Security in LAN - IPSEc, attacks, from layer 7 down to layer 2 . Part 2 : use case : which netwrok for which application. Two analyses, one based on IoT, one based on mobile communication 3G/4G

Content :
Part 1 - 8H, review of different security mechanisms and attacks. Part 2 : 2*4H : two scenarios using IoT and mobile network (lessons given by network companies)

Bibliography :

Requirements :
SRC06-RES, SRC08-RES, any network lessons (MAC, IP, TCP, wireless communication)

Organisation :

Evaluation :
2-hour written exam

Target :
5th year SRC - Major track,
Student of the M&N track MASTER I-MARS

Data Local Network	SRC09-LAN-DATA
Number of hours : 24.00 h	3.00 ECTS credit
CM : 10.00 h, CM : 10.00 h, TD : 2.00 h, TD : 2.00 h	
Reference Teacher(s) : UZEL FABIENNE	

Objectives :
2 parts : one on IPV6 and WLAN, one on WPAN based on IP

Content :
"Partie 1- 8H : Network administration, ipv6, inter-as routing . Partie 2- 8H- Introduction of some of wireless network using IP(bluetooth, wifi, wlan, wimax, ..)

"

Bibliography :

Requirements :
network, IP V4

Organisation :

Evaluation :
2-hour written exam

Target :
5th year SRC - Optional track "network design", Student of the M&N track MASTER I-MARS

Mobile Networks	SRC09-MOBILE
Number of hours : 12.00 h	1.00 ECTS credit
CM : 8.00 h, TD : 4.00 h	
Reference Teacher(s) : EL ZEIN GHAIS	

Objectives :
Acquisition of the fundamental foundations
of the field of cellular and mobile radio networks
through a description of the main techniques
used and their applications, focusing on the
physical layer of networks

Content :
1. Wireless Networks: history, market development, principle
2. Cellular Concept: frequency reuse, co-channel interference, traffic model, capacity, handover
3. Transmission Techniques (from 1G to 4G):
- 1G (RC2000, NMT, AMPS, TACS, ...)
- 2G (GSM/DCS, IS-95, PDC, D-AMPS, ...)
- 2.5G (GPRS, HSCSD, EDGE, ...)
- 3G (UMTS, cdma2000, IMT-2000, ...)
- 3.5G (HSDPA) - 3.75G (HSUPA)
- 3G++ (HSPA+)
- 3.9G (LTE) - 4G (LTE-Advanced, WiMax, ...)
4. Emerging Technologies: 5G
"

"1. Wireless Networks: history, market development, principle
2. Cellular Concept: frequency reuse, co-channel interference, traffic model, capacity, handover
3. Transmission Techniques (from 1G to 4G):
- 1G (RC2000, NMT, AMPS, TACS, ...)
- 2G (GSM/DCS, IS-95, PDC, D-AMPS, ...)
- 2.5G (GPRS, HSCSD, EDGE, ...)
- 3G (UMTS, cdma2000, IMT-2000, ...)
- 3.5G (HSDPA) - 3.75G (HSUPA)
- 3G++ (HSPA+)
- 3.9G (LTE) - 4G (LTE-Advanced, WiMax, ...)
4. Emerging Technologies: 5G
"

Bibliography :

Requirements :
Network architecture - Radiocommunications

Organisation :

Evaluation :
1-hour written exam

Target :
5th year SRC - Major track, MASTER I-MARS

Technical project	M&N09-PROJ
Number of hours : 360.00 h	8.00 ECTS credit
PR : 50.00 h	hand-out in English and course taught in English
Reference Teacher(s) : MORIN LUCE	

Objectives :
-Manage a project within a team, on a technical topic proposed by an industrial partner.
-Collaborate with an industrial partner and take into account industrial requirements and organization.
-Apply technical and management skills acquired during academic courses.
-Practice report writing and oral presentation on technical topics.

Content :
1. Meet industrial partner and write project functional specifications.
2. Task scheduling and task repartition.
3. State of the art and bibliographic research.
4. Experimental development and validation ; regular meetings with project advisor.
5. Report writing, preparation of presentation slides.
6. Oral defense of the project.

Examples of project topics:
-Visual closed-loop control of an AR-Drone
-Audio bench test for mobile phones
-Calibration of a network of heterogeneous cameras
-Direct WI-FI remote control
-CPL transmission of video stream on an ETTUS card
-Optimization of a conversion of audio sampling rate library on ARM architecture
-RFID for electronic passport reading in multi-platform Windows/Linux environment
-Activity and physiologic parameters measurement with a Kinect sensor

Bibliography :

Requirements :

Organisation :
-Teams of 4 to 6 students, including a project leader
-Topics proposed by industrial partners and work at Insa research/teaching labs.
-Regular meetings with the project advisor (a professor).
-Autonomous work over the whole semester, with dedicated time shifts (6 hour/week)
-Free access to software and hardware to teaching and research labs, industrial partner might provide software/hardware if necessary for the project.

Evaluation :
The work realized by each group is subject to a written report and an oral presentation before an audience comprised of fellow students. The jury is composed of professors and industrial partners.
A final mark awarded based on the quality of the work, written report and oral presentation.

Target :
M&N students from 5EII/5SRC/5INFO

English S9 Conversation	HUM09-ANGL-CONV
Number of hours : 10.00 h	1.50 ECTS credit
TD : 10.00 h, TD : 10.00 h	
Reference Teacher(s) : LE VOT PHILIPPE	

Objectives :
- Improving communication skills in everyday life situations as well as in a professional or social context.
- Obtaining or reinforcing C1 level, strongly advised/recommended by the CTI. t.

Content :
- Learning by doing: students will have to be able to speak and listen, write a document while showing they can solve problems, reason, convince and demonstrate in an articulate manner.
- Expressing oneself accurately and fluently: students will engage in activities requiring creative and reactive skills such as debates, role-plays, individual oral Power Point presentations, projects, based on scientific topics and current events.

Bibliography :
1. English Grammar in Use (Cambridge University Press)
2. Dictionnaire Collins Cobuild
3. Polycopié de l' INSA

Requirements :
Having taken and passed the TOEIC test during the previous two years (800 required)
or any other B2 certification recognized by the CTI.

Organisation :
- Each class lasts one hour and most classrooms are equipped with video and audio. A multimedia lab and computer rooms are also available for the students to work in a stimulating environment.
- Teaching resources include press articles, audio and video documents (TV reports, extracts from films and series) as well as the Internet.

Evaluation :
Continuous assessment: The final mark (out of 20) will be based on the attendance rate and the personal implication of the student during the class.

Target :

TOEIC 5th year	HUM09-ANGL-TOEIC
Number of hours : 20.00 h	1.50 ECTS credit
TD : 20.00 h, TD : 20.00 h	
Reference Teacher(s) : LE VOT PHILIPPE	

Objectives :
- Improving communication skills in everyday life situations as well as in company and business context.
- Obtaining or reinforcing the B2 level requested by the CTI.
- Obtaining 800 score at the final TOEIC test.

Content :
Learning by doing : students will have to be able to speak and listen, write a document while showing they can solve problems, reason, convince and demonstrate in an articulate manner.
Expressing oneself accurately and fluently : students will engage in activities requiring creative and reactive skills such as debates, role-plays, individual oral Power Point presentations, projects, based on scientific topics and current events.

Bibliography :
- English grammar in Use, Intermediate Edition (CUP)
- Robert and Collins bilingual dictionary or Collins Cobuild

Requirements :
Not having already taken and passed the TOEIC test during the previous two years
B1/B2 level advised

Organisation :
Each class lasts two hours and most classrooms are equipped with video and audio. A multimedia lab and computer rooms are also available for the students to work in a stimulating environment.
Teaching resources include press articles, audio and video documents (TV reports, extracts from films and series) as well as the Internet. B2 level tests are also taken throughout the course.

Evaluation :
Final mark based on :
TOEIC score at final exam + attendance (more than 4 non justified absences result in 0/20 mark).

Target :
5th year students who haven't already passed their TOEIC

Economics, Law and Business Studies A (Lean six sigma)	HUM09-PM-A
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
* Lean Six Sigma (28h / in French)
Lean Six Sigma is a methodology that enables firms to make their processes more effective and efficient. It¿s the current industry standard for process improvement designed to reduce waste and enhance output quality.

* Law (8h / in French)
Main principles of the French legal system

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies B (Human Resource Management)	HUM09-PM-B
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field)
- Understanding the importance of teamwork: making collective decisions and producing the expected work in time

Content :
* Human Resource Management (20h / in French)
    - Main current challenges of Human Resource Management
    - Human Resource Management¿s tools and organization
    - Focus on how team managers deal with Human Resource Management

* Law (8h / in French)
    Main principles of the French legal system

* Social legislation (8h / in French)
    Main principles of French social legislation
    Employment contract

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies C (Human Resources Management)	HUM09-PM-C
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field)
- Understanding the importance of teamwork: making collective decisions and producing the expected work in time

Content :
* Human Resource Management (20h / in French)
    - Main current challenges of Human Resource Management
    - Human Resource Management¿s tools and organization
    - Focus on how team managers deal with Human Resource Management

* Law (8h / in French)
    Main principles of the French legal system

* Social legislation (8h / in French)
    Main principles of French social legislation
    Employment contract

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies D (MANAGEMENT - ETHICS - RESPONSIBILITY)	HUM09-PM-D
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : GOURRET FANNY	

Objectives :
This course aims at enabling students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
The program's main objective is to provide a multidisciplinary approach to the field of innovation, strategy and industrial design. This course will give an overview of the innovative process.
During this program, participants will have the opportunity to explore a business case covering the first stage of a product development project.

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - S7 and S8

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advices to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies E (International Strategy and Development)	HUM09-PM-E
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : GOURRET FANNY	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time.

Content :
This course provides students with the tools necessary to understand and work effectively in today's international economic environment. It explores how innovative firms address new markets and compete outside their national frontiers. The course focuses on strategic choices regarding effective actions in international business.

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advice to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

Economics, Law and Business Studies F (sustainable development)	HUM09-PM-F
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, CM : 30.00 h, TD : 4.00 h, TD : 4.00 h	
Reference Teacher(s) : BOUGUENNEC CHRISTELLE	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.

Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
- Project Management (28 h / in French)
    - Efficient Project Management tools and organization according to PMI (Project Management Institute)
    - Agility
    - SCRUM

- Law (8 h / in French)
    Main principles of the French legal system

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - 1
ECONOMICS AND BUSINESS MANAGEMENT - 2

Organisation :
This course is opened to students with different engineering backgrounds. Students work together in small groups and gather the necessary information and advice to set out a final report. Groups also benefit from conferences and tutorial sessions performed by professional speakers.

Evaluation :
Continuous assessment (collective work)

Target :

SRC09-CONFERENCES	SRC09-CONF
Number of hours : 16.00 h	1.00 ECTS credit
CM : 16.00 h, CM : 16.00 h	
Reference Teacher(s) : PREVOTET JEAN-CHRISTOPHE	

Objectives :
Industrial or academic experts in various domains present small talks (typically 2h) about technical and scientific issues in their domain. The main idea is to open students to the world of industry and research and make them sensitive to state of the art issues.

Content :
The talks may vary depending on the availability of experts

Bibliography :

Requirements :

Organisation :

Evaluation :
PASS if every session is attended, FAIL otherwise.

Target :
5SRC and 5M&N

APES Responsabilités associatives à 1 crédit : Mission Diversité	HUMF1-APES DIV
Number of hours : 60.00 h	1.00 ECTS credit
DIV : 7.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 10

Parcours Formation Initiale SRC

1	SRC10-1		Internship	30.00
	SRC10-PFE	O	Work placement	30.00

O = compulsary, C= in choice , F= optional

Work placement	SRC10-PFE
Number of hours : 350.00 h	30.00 ECTS credit
ST : 350.00 h	
Reference Teacher(s) :	

Objectives :
This work placement must allow the student to acquire practical experience in a professional environment. The student will
aim to develop his teamwork, communication and observation skills, and improve his capacity to integrate a business
environment.

Content :
- Work placement with agreement (junior engineer level).
- At least 16 weeks duration.
- In France or abroad.
- Must be carried out in the second semester of the 5th year of studies.

Bibliography :

Requirements :

Organisation :
Writing a final report
Defence of the internship

Evaluation :
The final mark is obtained considering 3 steps :
* the amount and quality of work according the manager of the student,
* the quality of the writing report,
* the quality of the defence of the internship in front of an examining board.

Target :

Semestre 10

Parcours Média & Networks

1	SRC10-1		Internship	30.00
	SRC10-PFE	O	Work placement	30.00

O = compulsary, C= in choice , F= optional

Work placement	SRC10-PFE
Number of hours : 350.00 h	30.00 ECTS credit
ST : 350.00 h	
Reference Teacher(s) :	

Objectives :
This work placement must allow the student to acquire practical experience in a professional environment. The student will
aim to develop his teamwork, communication and observation skills, and improve his capacity to integrate a business
environment.

Content :
- Work placement with agreement (junior engineer level).
- At least 16 weeks duration.
- In France or abroad.
- Must be carried out in the second semester of the 5th year of studies.

Bibliography :

Requirements :

Organisation :
Writing a final report
Defence of the internship

Evaluation :
The final mark is obtained considering 3 steps :
* the amount and quality of work according the manager of the student,
* the quality of the writing report,
* the quality of the defence of the internship in front of an examining board.

Target :