

**Academic year 2024/2025**

**Courses offered by the programme**

## **Electronique et Télécommunications (E&T) Electronics & Telecommunications**

**Semester(s) : 5-6-7-8-9-10**

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 pedagogical 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
DET09-IMARS-D-CISY	
DET09-IMARS-D-DIRA	Radiofrequency and Antenna Devices, additional research work
DET09-IMARS-D-SYCA	Advanced Communication Systems, additionnal research work
DET09-IMARS-TASE-AN	Processing and Architecture of Analog Electronic Systems, additionnal research work
DET09-IMARS-TASE-NU	Processing and Architecture of Digital Electronic Systems, additionnal research work
DET09-M-SNET	Smart Networks
DET09-M-SYNS	System and Network Security

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

**Semestre 5**

**Parcours FISP**

<b>1</b>	<b>DET05-1</b>		<b>Electronics</b>	<b>8.00</b>
	DET05-ELEC	O	Electronics	6.00
	DET05-WTLB	O	Waves and Transmission Lines Basics	2.00
<b>2</b>	<b>DET05-2</b>		<b>Signal and Waves</b>	<b>8.50</b>
	DET05-SPB	O	Signal Processing - Basics	4.00
	ESM05-ANAL	O	Mathematical Analysis for the Engineer	1.50
	DET05-PROBA	O	Probabilities and statistics	1.50
	DET05-MATP	O	Mathematics	1.50
<b>3</b>	<b>DET05-3</b>		<b>Prerequisite</b>	<b>6.50</b>
	ESM05-INFOC	O	C language	1.50
	ESM05-LOG	O	Combinatory and Sequential Logic	2.00
	DET05-VHDL	O	VHDL	3.00
<b>5</b>	<b>HUM05-ISP/RISQ</b>		<b>ENSEIGNEMENTS D'HUMANITE S5 - FISP / RISQ</b>	<b>6.00</b>
	HUM05-ANGL	O	English	2.00
	HUM05-RISQ	O	Risk Management. Sustainable Development	1.50
	HUM05-EPS	O	Sport and physical Education	1.00
	HUMF1-ALL	C	German: Confirmed Level	1.50
	HUMF1-ESP	C	Spanish	1.50
	HUMF1-CHI	C	Chinese	1.50
	HUMF1-ITA	C	Italian	1.50
	HUMF1-JAP	C	Japanese	1.50
	HUMF1-RUS	C	Russian	1.50

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

<b>Electronics</b>	<b>DET05-ELEC</b>
<b>Number of hours : 88.00 h</b>	<b>6.00 ECTS credit</b>
<b>CM : 2.00 h, CM : 30.00 h, PR : 14.00 h, TD : 2.00 h, TD : 16.00 h, TP : 16.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**Objectives :**

- To be able to apply the main methods to study typical, basic circuits,
- To be able to make measurements on those circuits (handling in electronics laboratory) and carry out simulations ("spice" simulation)
- To work autonomously on a synthetic technical project.
- To know the basics on typical semi-conductor components and how they are manufactured
- To use semi-conductor components in electronic circuits (diodes, bipolar junction and field-effect transistors)

**Content :**

1. To study methods for linear circuits: linear circuits, physics and mathematics in circuit modelling, active and passive fundamental elements, fundamental laws and theorems, equivalent schemes, quadripole theory.
- \_2. Different functioning states of a linear system: time-harmonic and phasor representations and transfer functions, Bode plot, response to any pulse excitation, study of transitory states.
- \_3. Physics and component technology, semi-conductor devices: junction diode and bipolar junction transistor.
- \_4. Bipolar junction transistor: characteristics, polarisation, equivalent scheme, class A fundamental circuits, transistor association, varied integration structures, differential amplifier, transistor in high frequencies.
- \_5. Synthetic technical project over the entire module programme.

**Bibliography :**

- ""Electronique, Fondements et applications"", JP Pérez, C. Lagoutte, JY Fourniols, S. Bouhours, Dunod.
- ""Traité d'électricité et d'électronique, VIII"" ( 2 vol ), Chatelain, Dessoulavy, Dunod
- ""Introduction to semiconductor materials and Devices"", Ed. J. Wiley and Sons."

**Requirements :**

"Electricity" and "Electronics" from STPI

**Organisation :**

Revision of lecture notes and practical work.  
Personal input for project.

**Evaluation :**

"Two-hour written examination (coeff. 2)  
Mark for course work (coeff. 2)  
Mark for practical work (coeff. 1)  
Mark for project work (coeff. 1)"

**Target :**

3rd year SRC

<b>Waves and Transmission Lines Basics</b>	<b>DET05-WTLB</b>
<b>Number of hours : 18.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 5.00 h, CM : 8.00 h, CM : 5.00 h</b>	
<b>Reference Teacher(s) : LOISON Renaud</b>	

**Objectives :**

- To understand and to be able to analyse propagation phenomena (waves).
- To learn basics of high frequency transmission lines.

**Content :**

The course is divided in three parts :

- 1- 1D propagation 1D without dispersion : study of propagation characteristics through the analysis of non dispersive transmission lines (propagation equation, solutions, reflexion, transmission).
- 2- 1D propagation 1D with dispersion : study of propagation characteristics through the analysis of a dispersive transmission line (dispersion equation, group velocity, phase velocity, distorsion)
- 3- Multidimensional propagation (equation, plane wave, reflexion, transmission).

**Bibliography :**

Vibration and waves in physics", Iain G. Main, Cambridge University Press.

**Requirements :**

- ESM05-ANAL (Mathematical Analysis).
- SRC05-MATP (Mathematical prerequisites).
- SRC05-ELEC (Electronics).

**Organisation :**

**Evaluation :**

Two-hour written examination.

**Target :**

3rd year E&T students

<b>Signal Processing - Basics</b>	<b>DET05-SPB</b>
<b>Number of hours : 56.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 14.00 h, CM : 8.00 h, TD : 16.00 h, TP : 12.00 h, TP : 6.00 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**Objectives :**

From the decomposition of a signal based on basic functions, the purpose of this module is to address the transition tools between the time domain and the frequency domain. These tools of transformation are developed and described with respect to the time nature of the signal: continuous or discrete time. Then the notion of discrete transformation is addressed to prepare its settlement presence in signal processors. Finally, the filtering operations are described and the influence of these operations on the behavior of systems (stability, causality).

**Content :**

Nature (deterministic, random) and classification (energy and morphological) of signals. Vector representation of signals and description with basic functions. Analysis and synthesis of signals: Fourier series decomposition. Harmonic analysis of continuous-time deterministic signals: definition of the Fourier transform, duality of time and frequency description. Description of distribution operations: interest, definition and properties. Description of the convolution and correlation operations. Definition of the energy and power spectral density. Extension to the discrete-time deterministic signals: definition of the Fourier transform of a sampled signal, sampling theorem and Shannon criterion, time-frequency conversion, extension of the Fourier transform of a sequence. Extension to the discrete Fourier transform. Filtering deterministic signals: term behavior of filtering systems, characterization of filters, impulse response, transfer function.

**Bibliography :**

"Théorie et traitement des signaux", F de Coulon, Dunod  
 ""Eléments de théorie du signal : les signaux déterministes"", Jean-Pierre DELMAS, Ellipses  
 ""Traitement numérique des signaux - théorie et pratique"", M. Bellanger, Dunod  
 "Traitement numérique du signal - une introduction",A.W.M. Van den Eenden et N.A.M. Verhoeckx, Masson"

**Requirements :**

SRC05-MATP, ESM05-ANAL

**Organisation :**

**Evaluation :**

2 two-hour written examinations + 1 bonus mark based on several courseworks + 1 practical lab-course examination

**Target :**

3rd year E&T

<b>Mathematical Analysis for the Engineer</b>	<b>ESM05-ANAL</b>
<b>Number of hours : 20.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TD : 10.00 h</b>	
<b>Reference Teacher(s) : LEY Olivier</b>	

**Objectives :**

Integration, Fourier transform, complex analysis

**Content :**

1. Integration
  - Introduction to Lebesgue integral, integrable functions
  - Convergence theorems
  - Integrals with a parameter
  - Fubini's Theorem
  - Convolution
2. Fourier transform
  - Fourier transform of an integrable function
  - Properties and Inversion Theorem
  - Fourier transform of a square-integrable function
  - Plancherel theorem
3. Introduction to complex analysis
  - Holomorphic functions
  - Power series
  - Exponential and logarithmic functions
  - Complex line integral
  - Cauchy's formula
  - Residue Theorem
  - Methods of contour integration

**Bibliography :**

1. M. Bergounioux, Mathématiques pour le traitement du signal, Mathématiques appliquées pour le Master, 2ème édition, Dunod, 2014.
2. W. Rudin, Real and complex analysis. Third edition. McGraw-Hill Book Co., New York, 1987.

**Requirements :**

Mathematical analysis of first and second year

**Organisation :**

30h

**Evaluation :**

1 written examination

**Target :**

3rd year students

<b>Probabilities and statistics</b>	<b>DET05-PROBA</b>
<b>Number of hours : 20.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TD : 10.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

To familiarize students with the main definitions and the different concepts of probability and statistics. To know the basic definitions of combinatorial analysis and the calculus of probabilities. Use mathematical tools to identify the main elements in probability and statistics. Use the fundamental probability tools in order to apply them to the field of telecommunications.

**Content :**

"1 - Set & Count

Sets / permutation / arrangement / combination

Binomial coefficients / inclusion-exclusion principles

2 - Random variables

Conditional probability & independence

Discrete random variable / continuous random variable

Joint / marginal / fundamental inequalities distribution function

3 - Law of discrete probabilities

Uniform Discrete Law / Bernouilli / Binomial / Poisson

4 - Law of continuous probabilities

Gaussian / exponential / Rayleigh / Rice / Nakagami-m / Chi-square / Limit theorems"

**Bibliography :**

**Requirements :**

DET05-MATP

**Organisation :**

**Evaluation :**

"Mark for course work (coeff. 2)

Mark for continuous evaluation (coeff. 1)

"

**Target :**

3 E&T students



<b>Mathematics</b>	<b>DET05-MATP</b>
<b>Number of hours : 14.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 14.00 h</b>	
<b>Reference Teacher(s) : LE MAGOAROU Luc</b>	

**Objectives :**

To familiarize students with the handling of special functions and solving partial differential equations that they will need to use throughout the differentspecialty modules. Illustration by many applications in telecommunications.

**Content :**

- "1. Integrals
- 2. Error functions : erf, erfc, Q
- 3. Euler's integral and related functions : Beta and Gamma functions, Fresnel's integral
- 4. Bessel functions"

**Bibliography :**

Handbook of Mathematical Functions, with Formulas, Graphs, and Mathematical Tables, Edited by Milto Abramowitz and Irene A. Stegun; Dover Publications, Inc, NewYor1.

**Requirements :**

Mathematical level 2 : L2

**Organisation :**

**Evaluation :**

1 exam (2 hours)

**Target :**

<b>C language</b>	<b>ESM05-INFOC</b>
<b>Number of hours : 22.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 6.00 h, TD : 4.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : ARNALDI Bruno</b>	

**Objectives :**

Basic understanding of the C programming language.  
 Ability to resolve all common problems.  
 Find the minimal intersection of needs / C. language.  
 Writing and comprehension of the code. Syntax and associated semantic.

**Content :**

1. Introduction to C programming language:
  - Introduction.
  - Chain of production, from the code source to the executable.
2. Basic C:
  - Lexical entities.
  - Language syntax.
  - Variable declaration.
  - Predefined types.
  - Operators and expressions.
  - General structure of a program.
  - Basic input/output.
  - Control structures and instructions.
  - Fields: 1st form.
  - Functions and pass-by-value parameter passing.
3. Advanced C:
  - Pointers.
  - Functions and pass-by-address parameter passing.
  - Standard library functions.
  - Memory models for functions and pointers.
  - Fields : 2nd form.
  - New types and types constructor.
  - Explicit type conversion.
  - File input/output.
  - Allocation class.
  - Dynamic Allocation.
  - Pointers to functions.

**Bibliography :**

J.P. BRAQUELAIRE. Méthodologie de la programmation en langage C - Principes et applications. Manuels Informatiques Masson. Masson, 1993.  
 J.P. BRAQUELAIRE. Méthodologie de la programmation en langage C - Norme C99 - API POSIX. Sciences Sup. Dunod, 2005.  
 C. DELANOY. Programmer en langage C, avec exercices corrigés. Eyrolles, 1997.  
 B.W. KERNIGHAN and D.M. RITCHIE. Le langage C. Manuels Informatiques Masson. Masson, 1990.  
 J.L NEBUT. Le langage C - définition de la norme ANSI. Technical Report Cours C81, IFSIC -Université de Rennes 1, juillet 1989.

**Requirements :**

Understanding of Algorithms Foundations

**Organisation :**

Revision of the lecture notes.  
 6 hours of course, 4 hours of directed work and 12 hours of practical work

**Evaluation :**

2-hour written examination at the middle of the first semester (documents allowed).

**Target :**

<b>Combinatory and Sequential Logic</b>	<b>ESM05-LOG</b>
<b>Number of hours : 26.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 14.00 h, TD : 12.00 h</b>	
<b>Reference Teacher(s) : DARDAILLON Mickael</b>	

**Objectives :**

Introduction to digital circuits. Methods and tools for the design of digital circuit.

**Content :**

Combinatory Logic

Logic basics, logic gates and logic functions. Boole Algebra

Logic Simplification/minimisation using Karnaugh.

Design of complex logic systems : multiplexer, decoder, adder

Sequential Logic

Sequential logic basics : synchronous et asynchronous flip-flops

Complex systems : counter, register, shifting

Temporal analysis

Complex Systems, state machines (Moore and Mealy). Design process starting from the specifications

**Bibliography :**

TOCCI R. J., "Circuits numériques - Théorie et applications", Dunod, 1992.

NKETSIA A., " Circuits logiques", Collection TechnoSup, 2000

BRIE C., "Logique combinatoire et séquentielle : Méthodes, outils et réalisations", Editions Ellipses, collection Technosup, 2002.

Strandh R., " Architecture de l'Ordinateur ", Dunod , 2005

**Requirements :**

**Organisation :**

lectures, preparing exercises during TD

**Evaluation :**

Written examination of 2 hours, with documents

**Target :**

3rd year

<b>VHDL</b>	<b>DET05-VHDL</b>
<b>Number of hours : 36.00 h</b>	<b>3.00 ECTS credit</b>
<b>CM : 8.00 h, TD : 6.00 h, TP : 8.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**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 :**

Le langage VHDL -Jacques Weber, Maurice Meaudre - Dunod Initiation au langage VHDL - Michel Aumiaux -

**Requirements :**

ESM05-LOG

**Organisation :**

**Evaluation :**

Written examination

**Target :**

3rd year E&T

<b>English</b>	<b>HUM05-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**Objectives :**

Improve expression, comprehension and interaction skills within everyday contexts, with special emphasis on professional and social life.

Language Objectives

Obtain or reinforce B2 level (as required for graduation and defined by CECRL )

**Content :**

-Action-oriented approach - learning by doing :

students have to listen and speak, write documents while using their problem-solving, reasoning, arguing, and demonstrating capabilities, in an articulate manner.

-Expressing oneself accurately by a rigorous use of syntax and phonology :

Activities requiring creative and reactive skills, ranging from debating, role-playing, individual oral presentations (PowerPoint), projects ... are based on scientific topics and current events.

-Building up specific skills in connection with the working world :

- writing e-mails
- conducting telephone conversations
- technical English
- intercultural contexts

In addition to the English course, a 90-minute remedial course takes place every week (over 10 weeks), in which students can update their various skills (listening and reading, writing, speaking and interacting) in small groups. Remedial classes are compulsory for all students that did poorly in their start-of-term placement test - and optional for those who feel they need to attend. There is no specific assessment for this course.

**Bibliography :**

- Dictionnaire Robert et Collins bilingue, or Collins Cobuild unilingue
- English Grammar in Use (Cambridge University Press)

**Requirements :**

A good command of the STPI curriculum is essential : B1/B2

**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 students to work in a stimulating environment.

- Teaching resources include press articles, audio and video documents (TV reports, film and series extracts) as well as the Internet.
- Regular personal work is required. Students must be curious and practise their English outside the classroom.

**Evaluation :**

Two-hour written test.(2/3)

Individual oral presentation in class.(1/3)

**Target :**

<b>Risk Management. Sustainable Development</b>	<b>HUM05-RISQ</b>
<b>Number of hours : 22.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 22.00 h, CM : 22.00 h</b>	
<b>Reference Teacher(s) : GALL Philippe</b>	

**Objectives :**

To create awareness that the environment in which the engineer works is full of uncertainties and risks. The engineer must nevertheless be in control of his choices and actions within the limits that are defined by acceptable risk in the contemporary context of sustainable development  
 How do you position yourself as a scientist in relation to the 17 Sustainable Development Goals (SDGs)  
 Acquire the basics of risk prevention, in particular for health  
 Learn about occupational risk prevention  
 Understand the links between work and health  
 Understand types of work accident  
 Professional risk assessment  
 Application of an occupational health and safety approach  
 Awareness of the impact of decisions  
 Talks given by Professionals

**Content :**

How do you position yourself as a scientist in relation to the 17 Sustainable Development Goals (SDGs)  
 Acquire the basics of risk prevention, in particular for health  
 Learn about occupational risk prevention  
 Understand the links between work and health  
 Understand types of work accident  
 Professional risk assessment  
 Application of an occupational health and safety approach  
 Awareness of the impact of decisions  
 Talks given by Professionals

**Bibliography :**

**Requirements :**

**Organisation :**

Sulitest  
 2 Modules by distance learning (INRS)  
 Face to face meetings with professionals  
 MOOC – OpenClassroom: develop an OHS strategy  
 Hybrid training alternating face-to-face training and distance learning with validation tests and peer work evaluation

**Evaluation :**

Tests upon completion of each training module  
 Grade out of 20 is derived from the Sulitest test, 2 grades out of 10  
 A module is validated if the grade is superior or equal to 10/20 for INRS modules and one grade out of for the MOOC (combining 3 quizzes and a peer evaluation)  
 \_ Le rattrapage ne concerne que l'élément de module ayant une note inférieure à 10/20. La note du module après rattrapage ne peut en aucun cas excéder 10/20.  
 \_ La note de rattrapage est prise en compte dans le calcul de la nouvelle note finale du module uniquement si elle améliore cette note.  
 Un module non validé (Moyenne finale inférieure à 10/20) peut être acquis par compensation à la fin du semestre si la moyenne générale du semestre (moyenne de tous les modules du semestre en cours) est supérieure ou égale à 10/20.

**Target :**

<b>Sport and physical Education</b>	<b>HUM05-EPS</b>
<b>Number of hours : 24.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 24.00 h, TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**



<b>German: Confirmed Level</b>	<b>HUMF1-ALL</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

To consolidate secondary school level learning outcomes

To attain, as a basic minimum, the B1 level by the end of the first cycle

To practise written and oral comprehension through the use of contemporary supports and multimedia To develop level of oral expression through exercises in small groups and class discussions

To demonstrate and perfect your skills in German through project work

Support for foreign exchange and work placements

**Content :**

- Exercises to practise spoken German for everyday situations and professional life
- Study of newspaper articles, broadcasts, videos
- Study of current affairs (politics, economics, sociology and culture) in Germanophone countries
- Introduction to economic and professional German
- Grammar revision
- Cultural openness (film studies, exhibitions, music)

**Bibliography :**

- DUDEN Bilingual Dictionary (German-French/French-German)
- Grammatik Aktiv A1-B1, Cornelsen (mit Audio CD)\_- Schritte-Ubungsgrammatik A1-B1, Hueber-Verlag
- Übungsgrammatik für die Grundstufe, Hueber-Verlag (Moodle) - Na also!
- Waltraud Legros, Ellipses\_- Manuel : Menschen hier, Hueber-Verlag
- Deutsch perfekt (periodical) -
- Deutsche Welle/ ZDF logo (web) -
- multimedia supports (web)

**Requirements :**

Intermediate German: B1 level

**Organisation :**

1h30 per week; 21h face-to-face lessons per semester

Personal Study time: 14h

Total: 35 h

Students are encouraged to regularly read news articles in German and to view videos and film series in addition to work assigned between lessons.

**Evaluation :**

Basic level : continuous assessment

Intermediate level : continuous assessment

Advanced level : continuous assessment

**Target :**

S1: Final Grade

<b>Spanish</b>	<b>HUMF1-ESP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : AMARGOS GUILLERAY Marine</b>	

**Objectives :**

- Practising and strengthening of one's knowledge in the Spanish language and culture (Spanish culture, Spanish and Latin-American civilizations, societal developments).
- How to manage team projects
- Adapting to multicultural environments
- Understanding social, technological and economical challenges in Spanish-speaking countries.

**Content :**

Written and oral expression and comprehension.

**Bibliography :**

1. PASTOR Enrique and PROST Gisèle : "La grammaire active de l'espagnol", Le livre de poche, collection Les Langues modernes.
2. BECHERELLE, "El arte de conjugar en espanol", Hatier.
3. Larousse bilingual dictionary, Le Grand Dictionnaire de Garcia y Pelayo et Testas, Dictionary Hispano Bordas.
4. "Passez-moi l'expression en espagnol", Belin.
5. "El espanol en la prensa", Belin.

**Requirements :**

B1 level

**Organisation :**

- Reinforcing grammar / conjugation
- Reading and oral comprehension
- Writing and speaking (debates, drama).

Advice : Read in Spanish : contemporary novels, comics (Tintin, Astérix, Mafalda), magazines (Cambio 16, Epoca, Vocablo ) available at the library.

Visit the Internet pages of the Spanish and Latin-American newspapers (lavanguardia.es, elpais.es...)

Listen to Spanish National Radio programmes (RNE) on Internet.

Watch TV programmes on RTVE.es.

Read tourist guides on Spanish-speaking countries available at the library.

**Evaluation :**

Continuous assessment

**Target :**

3rd, 4th, 5th year

<b>Chinese</b>	<b>HUMF1-CHI</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

To acquire the basics of Chinese, Essential structures and vocabulary, Comprehension, expression and pronunciation, Use of everyday Chinese.

**Content :**

Oral skills : corrective phonetics (pinyin system), listening to and analysis of complex sentences and simple texts, oral exercises (student-student / student-teacher), introduction of new characters (pronunciation and tone accentuation).  
 Written skills : prose/translation, written production of complex sentences and simple texts, learning and reinforcement of grammatical and vocabulary mechanisms, oral and written Chinese, learning of new characters (order of lines, basic ideograms), reading and analysis of texts, text commentary.

**Bibliography :**

1. Le chinois comme en Chine, Bernard Allanic, Presses Universitaires de Rennes, 2009
  2. Le chinois contemporain, WU Zhongwei, Sinolingua, 2010
  3. Faire l'expérience du chinois, ZHANG Rumei, Ai Xin, Higher Education Press, 2006
- Other documents will be added to these basic books to provide the students with a wide panel of practical exercises.

**Requirements :**

**Organisation :**

Students are required to read the texts from the lessons (in character form), to rewrite the new characters, to work on the application exercises on grammar, lexical and morphological points, to ask questions on the texts from the lessons, to do prose and translation exercises.

**Evaluation :**

Final mark

**Target :**

<b>Italian</b>	<b>HUMF1-ITA</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : KERSUSAN Sylvia</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Level 1 Beginner :

To introduce the Italian language and Italian culture, to express the fundamentals in writing and orally

Level 2 Advanced Beginner:

By the end of the course, students should be able to converse and write in Italian

Level 3 Intermediate:

To enable students to develop further on themes relating to art, civilisation, literature and cinema

**Content :**

Oral expression and comprehension:

reading with the teacher's guidance on phonetic and grammatical corrections

reading situations in the text, viewing films and reading literary texts and press articles

Written expression and Comprehension:

completing text-based exercises with particular attention to difficulties

summarising situations in available texts and films studied in class

**Bibliography :**

La lingua italiana per Stranieri 1°, 2°, 3°P K.Katerinov

La prova orale 1,2,3 T.Marin

Texts taken from newspapers and Italian magazines, films by famous film directors

**Requirements :**

Level 1 Beginner: none

Level 2 Advanced Beginner : to have attended the Italian Beginner lessons

Level 3 Intermediate: to have a good knowledge of the Italian language

**Organisation :**

1h30 of face-face lessons per week; 21h per semester

Personal Study: 14h

To read the photocopied texts provided

**Evaluation :**

Final grade.

**Target :**

S1: Final Grade

<b>Japanese</b>	<b>HUMF1-JAP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Niveau débutant (A1):

- awareness of particularities (phonetics, syntax)
- discovery of Japanese culture, traditions, customs
- learning the two systems of writing (Hiragana and Katakana)
- to be able to use spoken Japanese in everyday situations

Intermediate level (A2):

- introduction ideogrammes (60 kanji)
- reading simple texts (with Manga, etc...)
- writing simple texts
- to be able to use spoken Japanese in everyday situations

Advanced level (B1, B2):

- learning kanji (60-200)
- acquiring the four skills (written and oral comprehension, written and oral expression) for travel or study in Japan

**Content :**

Level 1 Beginner (A1):

- Perfecting Hiragana et Katakana - reading Manga
- Lesson 5: speaking about pastimes
- Lesson 6: using transport
- Lesson 7: shopping
- Lesson 8: expressing feelings

Level 2 Beginner (A2):

- learning 30 kanji - reading Manga
- basic Grammar
- reading and writing simple texts
- learning how to communicate in everyday situations

Intermediate level (B1, B2) :

- learning to use more than 30 kanji
- reading Manga
- acquiring the four skills (written and oral comprehension, written and oral expression)

**Bibliography :**

Level 1 Beginner (A1): Margot, 3A Network, to be published, Japan.

Level 2 Beginner (A2): Daichi, 1, 3A Network, 2008, Japan.

Level 3 Intermediate (B1, B2): Minna no Nihongo, I et II, 3A Network, 1998, Japan.

+ Satoru Koyama, J. Bridge, Bonjinsha, 2007, Japan.

**Requirements :**

Level 1: none.

Level 2: to have taken Level A1 Beginner course

Level 3: to have taken Beginner Levels A1 and A2

**Organisation :**

The teaching follows the TU format.

In each session there is an explanation of the structures which are then illustrated by examples and by exercises and conversation which the students participate in.

**Evaluation :**

S1: Final Grade

**Target :**

<b>Russian</b>	<b>HUMF1-RUS</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Russian beginner : acquire A1 level

Russian intermediary : acquire A2/B1 level

**Content :**

Acquisition of grammatical basis and commonplace vocabulary.

Training of the 5 skills, oral and written comprehension, oral and written expression, interaction.

The stress is put on written and oral communication, firstly in the frame of daily situations, then with a progressive introduction of other themes and opening on the professional communication.

Training with varied media (written, audio, video)

Individual exercises and works in groups, talks from the intermediate level on.

Grammar program depending on the level.

(Inter) cultural opening

**Bibliography :**

To be seen with the teacher

**Requirements :**

**Organisation :**

one hour -and-a-half courses per week in SUPELEc

**Evaluation :**

Final grade (overseen by SUPELEC).

**Target :**

**Semestre 5**

**Parcours Formation Initiale E&T**

<b>1</b>	<b>DET05-1</b>		<b>Electronics</b>	<b>8.00</b>
	DET05-ELEC	O	Electronics	6.00
	DET05-WTLB	O	Waves and Transmission Lines Basics	2.00
<b>2</b>	<b>DET05-2</b>		<b>Signal and Waves</b>	<b>8.50</b>
	DET05-SPB	O	Signal Processing - Basics	4.00
	ESM05-ANAL	O	Mathematical Analysis for the Engineer	1.50
	DET05-PROBA	O	Probabilities and statistics	1.50
	DET05-MATP	O	Mathematics	1.50
<b>3</b>	<b>DET05-3</b>		<b>Prerequisite</b>	<b>6.50</b>
	ESM05-INFOC	O	C language	1.50
	ESM05-LOG	O	Combinatory and Sequential Logic	2.00
	DET05-VHDL	O	VHDL	3.00
<b>4</b>	<b>HUM05</b>		<b>Non-scientific syllabus S5</b>	<b>7.00</b>
	HUM05-RISQ	O	Risk Management. Sustainable Development	1.50
	HUM05-ANGL	O	English	2.00
	HUM05-PSH	O	Human sciences project	2.50
	HUM05-EPS	O	Sport and physical Education	1.00
<b>8</b>	<b>HUMF1-ELSA Mus</b>		<b>Music with studies</b>	<b>1.00</b>
	HUMF1-MUS	F	Music Studies	1.00
<b>10</b>	<b>HUMF1-SAM(DIV)</b>		<b>SAM : APES Responsabilités Associatives</b>	<b>1.00</b>
	HUMF1-APES DIV	F	Association membership & responsibilities 1 credit - Diversity Mission	1.00
<b>12</b>	<b>HUMF1-RIE</b>		<b>RIE : Recherche Innovation Entrepreneuriat</b>	<b>1.00</b>
	HUMF1- RI	F	Recherche Innovation	1.00
	HUMF1- IE	F	INNOVATION & ENTREPRENEURSHIP	1.00

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



<b>Electronics</b>	<b>DET05-ELEC</b>
<b>Number of hours : 88.00 h</b>	<b>6.00 ECTS credit</b>
<b>CM : 2.00 h, CM : 30.00 h, PR : 14.00 h, TD : 2.00 h, TD : 16.00 h, TP : 16.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**Objectives :**

- To be able to apply the main methods to study typical, basic circuits,
- To be able to make measurements on those circuits (handling in electronics laboratory) and carry out simulations ("spice" simulation)
- To work autonomously on a synthetic technical project.
- To know the basics on typical semi-conductor components and how they are manufactured
- To use semi-conductor components in electronic circuits (diodes, bipolar junction and field-effect transistors)

**Content :**

1. To study methods for linear circuits: linear circuits, physics and mathematics in circuit modelling, active and passive fundamental elements, fundamental laws and theorems, equivalent schemes, quadripole theory.
- \_2. Different functioning states of a linear system: time-harmonic and phasor representations and transfer functions, Bode plot, response to any pulse excitation, study of transitory states.
- \_3. Physics and component technology, semi-conductor devices: junction diode and bipolar junction transistor.
- \_4. Bipolar junction transistor: characteristics, polarisation, equivalent scheme, class A fundamental circuits, transistor association, varied integration structures, differential amplifier, transistor in high frequencies.
- \_5. Synthetic technical project over the entire module programme.

**Bibliography :**

- ""Electronique, Fondements et applications"", JP Pérez, C. Lagoutte, JY Fourniols, S. Bouhours, Dunod.
- ""Traité d'électricité et d'électronique, VIII"" ( 2 vol ), Chatelain, Dessoulavy, Dunod
- ""Introduction to semiconductor materials and Devices"", Ed. J. Wiley and Sons."

**Requirements :**

"Electricity" and "Electronics" from STPI

**Organisation :**

Revision of lecture notes and practical work.  
Personal input for project.

**Evaluation :**

"Two-hour written examination (coeff. 2)  
Mark for course work (coeff. 2)  
Mark for practical work (coeff. 1)  
Mark for project work (coeff. 1)"

**Target :**

3rd year SRC

<b>Waves and Transmission Lines Basics</b>	<b>DET05-WTLB</b>
<b>Number of hours : 18.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 5.00 h, CM : 8.00 h, CM : 5.00 h</b>	
<b>Reference Teacher(s) : LOISON Renaud</b>	

**Objectives :**

- To understand and to be able to analyse propagation phenomena (waves).
- To learn basics of high frequency transmission lines.

**Content :**

The course is divided in three parts :

- 1- 1D propagation 1D without dispersion : study of propagation characteristics through the analysis of non dispersive transmission lines (propagation equation, solutions, reflexion, transmission).
- 2- 1D propagation 1D with dispersion : study of propagation characteristics through the analysis of a dispersive transmission line (dispersion equation, group velocity, phase velocity, distorsion)
- 3- Multidimensional propagation (equation, plane wave, reflexion, transmission).

**Bibliography :**

Vibration and waves in physics", Iain G. Main, Cambridge University Press.

**Requirements :**

- ESM05-ANAL (Mathematical Analysis).
- SRC05-MATP (Mathematical prerequisites).
- SRC05-ELEC (Electronics).

**Organisation :**

**Evaluation :**

Two-hour written examination.

**Target :**

3rd year E&T students

<b>Signal Processing - Basics</b>	<b>DET05-SPB</b>
<b>Number of hours : 56.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 14.00 h, CM : 8.00 h, TD : 16.00 h, TP : 12.00 h, TP : 6.00 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**Objectives :**

From the decomposition of a signal based on basic functions, the purpose of this module is to address the transition tools between the time domain and the frequency domain. These tools of transformation are developed and described with respect to the time nature of the signal: continuous or discrete time. Then the notion of discrete transformation is addressed to prepare its settlement presence in signal processors. Finally, the filtering operations are described and the influence of these operations on the behavior of systems (stability, causality).

**Content :**

Nature (deterministic, random) and classification (energy and morphological) of signals. Vector representation of signals and description with basic functions. Analysis and synthesis of signals: Fourier series decomposition. Harmonic analysis of continuous-time deterministic signals: definition of the Fourier transform, duality of time and frequency description. Description of distribution operations: interest, definition and properties. Description of the convolution and correlation operations. Definition of the energy and power spectral density. Extension to the discrete-time deterministic signals: definition of the Fourier transform of a sampled signal, sampling theorem and Shannon criterion, time-frequency conversion, extension of the Fourier transform of a sequence. Extension to the discrete Fourier transform. Filtering deterministic signals: term behavior of filtering systems, characterization of filters, impulse response, transfer function.

**Bibliography :**

"Théorie et traitement des signaux", F de Coulon, Dunod  
 ""Eléments de théorie du signal : les signaux déterministes"", Jean-Pierre DELMAS, Ellipses  
 ""Traitement numérique des signaux - théorie et pratique"", M. Bellanger, Dunod  
 "Traitement numérique du signal - une introduction",A.W.M. Van den Eenden et N.A.M. Verhoeckx, Masson"

**Requirements :**

SRC05-MATP, ESM05-ANAL

**Organisation :**

**Evaluation :**

2 two-hour written examinations + 1 bonus mark based on several courseworks + 1 practical lab-course examination

**Target :**

3rd year E&T

<b>Mathematical Analysis for the Engineer</b>	<b>ESM05-ANAL</b>
<b>Number of hours : 20.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TD : 10.00 h</b>	
<b>Reference Teacher(s) : LEY Olivier</b>	

**Objectives :**

Integration, Fourier transform, complex analysis

**Content :**

1. Integration
  - Introduction to Lebesgue integral, integrable functions
  - Convergence theorems
  - Integrals with a parameter
  - Fubini's Theorem
  - Convolution
2. Fourier transform
  - Fourier transform of an integrable function
  - Properties and Inversion Theorem
  - Fourier transform of a square-integrable function
  - Plancherel theorem
3. Introduction to complex analysis
  - Holomorphic functions
  - Power series
  - Exponential and logarithmic functions
  - Complex line integral
  - Cauchy's formula
  - Residue Theorem
  - Methods of contour integration

**Bibliography :**

1. M. Bergounioux, Mathématiques pour le traitement du signal, Mathématiques appliquées pour le Master, 2ème édition, Dunod, 2014.
2. W. Rudin, Real and complex analysis. Third edition. McGraw-Hill Book Co., New York, 1987.

**Requirements :**

Mathematical analysis of first and second year

**Organisation :**

30h

**Evaluation :**

1 written examination

**Target :**

3rd year students

<b>Probabilities and statistics</b>	<b>DET05-PROBA</b>
<b>Number of hours : 20.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TD : 10.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

To familiarize students with the main definitions and the different concepts of probability and statistics. To know the basic definitions of combinatorial analysis and the calculus of probabilities. Use mathematical tools to identify the main elements in probability and statistics. Use the fundamental probability tools in order to apply them to the field of telecommunications.

**Content :**

"1 - Set & Count  
 Sets / permutation / arrangement / combination  
 Binomial coefficients / inclusion-exclusion principles  
 2 - Random variables  
 Conditional probability & independence  
 Discrete random variable / continuous random variable  
 Joint / marginal / fundamental inequalities distribution function  
 3 - Law of discrete probabilities  
 Uniform Discrete Law / Bernouilli / Binomial / Poisson  
 4 - Law of continuous probabilities  
 Gaussian / exponential / Rayleigh / Rice / Nakagami-m / Chi-square / Limit theorems"

**Bibliography :**

**Requirements :**

DET05-MATP

**Organisation :**

**Evaluation :**

"Mark for course work (coeff. 2)  
 Mark for continuous evaluation (coeff. 1)  
 "

**Target :**

3 E&T students

<b>Mathematics</b>	<b>DET05-MATP</b>
<b>Number of hours : 14.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 14.00 h</b>	
<b>Reference Teacher(s) : LE MAGOAROU Luc</b>	

**Objectives :**

To familiarize students with the handling of special functions and solving partial differential equations that they will need to use throughout the differentspecialty modules. Illustration by many applications in telecommunications.

**Content :**

- "1. Integrals
- 2. Error functions : erf, erfc, Q
- 3. Euler's integral and related functions : Beta and Gamma functions, Fresnel's integral
- 4. Bessel functions"

**Bibliography :**

Handbook of Mathematical Functions, with Formulas, Graphs, and Mathematical Tables, Edited by Milto Abramowitz and Irene A. Stegun; Dover Publications, Inc, NewYor1.

**Requirements :**

Mathematical level 2 : L2

**Organisation :**

**Evaluation :**

1 exam (2 hours)

**Target :**

<b>C language</b>	<b>ESM05-INFOC</b>
<b>Number of hours : 22.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 6.00 h, TD : 4.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : ARNALDI Bruno</b>	

**Objectives :**

Basic understanding of the C programming language.  
 Ability to resolve all common problems.  
 Find the minimal intersection of needs / C. language.  
 Writing and comprehension of the code. Syntax and associated semantic.

**Content :**

1. Introduction to C programming language:
  - Introduction.
  - Chain of production, from the code source to the executable.
2. Basic C:
  - Lexical entities.
  - Language syntax.
  - Variable declaration.
  - Predefined types.
  - Operators and expressions.
  - General structure of a program.
  - Basic input/output.
  - Control structures and instructions.
  - Fields: 1st form.
  - Functions and pass-by-value parameter passing.
3. Advanced C:
  - Pointers.
  - Functions and pass-by-address parameter passing.
  - Standard library functions.
  - Memory models for functions and pointers.
  - Fields : 2nd form.
  - New types and types constructor.
  - Explicit type conversion.
  - File input/output.
  - Allocation class.
  - Dynamic Allocation.
  - Pointers to functions.

**Bibliography :**

J.P. BRAQUELAIRE. Méthodologie de la programmation en langage C - Principes et applications. Manuels Informatiques Masson. Masson, 1993.  
 J.P. BRAQUELAIRE. Méthodologie de la programmation en langage C - Norme C99 - API POSIX. Sciences Sup. Dunod, 2005.  
 C. DELANOY. Programmer en langage C, avec exercices corrigés. Eyrolles, 1997.  
 B.W. KERNIGHAN and D.M. RITCHIE. Le langage C. Manuels Informatiques Masson. Masson, 1990.  
 J.L NEBUT. Le langage C - définition de la norme ANSI. Technical Report Cours C81, IFSIC -Université de Rennes 1, juillet 1989.

**Requirements :**

Understanding of Algorithms Foundations

**Organisation :**

Revision of the lecture notes.  
 6 hours of course, 4 hours of directed work and 12 hours of practical work

**Evaluation :**

2-hour written examination at the middle of the first semester (documents allowed).

**Target :**



<b>Combinatory and Sequential Logic</b>	<b>ESM05-LOG</b>
<b>Number of hours : 26.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 14.00 h, TD : 12.00 h</b>	
<b>Reference Teacher(s) : DARDAILLON Mickael</b>	

**Objectives :**

Introduction to digital circuits. Methods and tools for the design of digital circuit.

**Content :**

Combinatory Logic

Logic basics, logic gates and logic functions. Boole Algebra

Logic Simplification/minimisation using Karnaugh.

Design of complex logic systems : multiplexer, decoder, adder

Sequential Logic

Sequential logic basics : synchronous et asynchronous flip-flops

Complex systems : counter, register, shifting

Temporal analysis

Complex Systems, state machines (Moore and Mealy). Design process starting from the specifications

**Bibliography :**

TOCCI R. J., "Circuits numériques - Théorie et applications", Dunod, 1992.

NKETSIA A., " Circuits logiques", Collection TechnoSup, 2000

BRIE C., "Logique combinatoire et séquentielle : Méthodes, outils et réalisations", Editions Ellipses, collection Technosup, 2002.

Strandh R., " Architecture de l'Ordinateur ", Dunod , 2005

**Requirements :**

**Organisation :**

lectures, preparing exercises during TD

**Evaluation :**

Written examination of 2 hours, with documents

**Target :**

3rd year

<b>VHDL</b>	<b>DET05-VHDL</b>
<b>Number of hours : 36.00 h</b>	<b>3.00 ECTS credit</b>
<b>CM : 8.00 h, TD : 6.00 h, TP : 8.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**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 :**

Le langage VHDL -Jacques Weber, Maurice Meaudre - Dunod Initiation au langage VHDL - Michel Aumiaux -

**Requirements :**

ESM05-LOG

**Organisation :**

**Evaluation :**

Written examination

**Target :**

3rd year E&T

<b>Risk Management. Sustainable Development</b>	<b>HUM05-RISQ</b>
<b>Number of hours : 22.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 22.00 h, CM : 22.00 h</b>	
<b>Reference Teacher(s) : GALL Philippe</b>	

**Objectives :**

To create awareness that the environment in which the engineer works is full of uncertainties and risks. The engineer must nevertheless be in control of his choices and actions within the limits that are defined by acceptable risk in the contemporary context of sustainable development  
 How do you position yourself as a scientist in relation to the 17 Sustainable Development Goals (SDGs)  
 Acquire the basics of risk prevention, in particular for health  
 Learn about occupational risk prevention  
 Understand the links between work and health  
 Understand types of work accident  
 Professional risk assessment  
 Application of an occupational health and safety approach  
 Awareness of the impact of decisions  
 Talks given by Professionals

**Content :**

How do you position yourself as a scientist in relation to the 17 Sustainable Development Goals (SDGs)  
 Acquire the basics of risk prevention, in particular for health  
 Learn about occupational risk prevention  
 Understand the links between work and health  
 Understand types of work accident  
 Professional risk assessment  
 Application of an occupational health and safety approach  
 Awareness of the impact of decisions  
 Talks given by Professionals

**Bibliography :**

**Requirements :**

**Organisation :**

Sulitest  
 2 Modules by distance learning (INRS)  
 Face to face meetings with professionals  
 MOOC – OpenClassroom: develop an OHS strategy  
 Hybrid training alternating face-to-face training and distance learning with validation tests and peer work evaluation

**Evaluation :**

Tests upon completion of each training module  
 Grade out of 20 is derived from the Sulitest test, 2 grades out of 10  
 A module is validated if the grade is superior or equal to 10/20 for INRS modules and one grade out of for the MOOC (combining 3 quizzes and a peer evaluation)  
 \_ Le rattrapage ne concerne que l'élément de module ayant une note inférieure à 10/20. La note du module après rattrapage ne peut en aucun cas excéder 10/20.  
 \_ La note de rattrapage est prise en compte dans le calcul de la nouvelle note finale du module uniquement si elle améliore cette note.  
 Un module non validé (Moyenne finale inférieure à 10/20) peut être acquis par compensation à la fin du semestre si la moyenne générale du semestre (moyenne de tous les modules du semestre en cours) est supérieure ou égale à 10/20.

**Target :**

<b>English</b>	<b>HUM05-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**Objectives :**

Improve expression, comprehension and interaction skills within everyday contexts, with special emphasis on professional and social life.

Language Objectives

Obtain or reinforce B2 level (as required for graduation and defined by CECRL )

**Content :**

-Action-oriented approach - learning by doing :

students have to listen and speak, write documents while using their problem-solving, reasoning, arguing, and demonstrating capabilities, in an articulate manner.

-Expressing oneself accurately by a rigorous use of syntax and phonology :

Activities requiring creative and reactive skills, ranging from debating, role-playing, individual oral presentations (PowerPoint), projects ... are based on scientific topics and current events.

-Building up specific skills in connection with the working world :

- writing e-mails
- conducting telephone conversations
- technical English
- intercultural contexts

In addition to the English course, a 90-minute remedial course takes place every week (over 10 weeks), in which students can update their various skills (listening and reading, writing, speaking and interacting) in small groups. Remedial classes are compulsory for all students that did poorly in their start-of-term placement test - and optional for those who feel they need to attend. There is no specific assessment for this course.

**Bibliography :**

- Dictionnaire Robert et Collins bilingue, or Collins Cobuild unilingue
- English Grammar in Use (Cambridge University Press)

**Requirements :**

A good command of the STPI curriculum is essential : B1/B2

**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 students to work in a stimulating environment.

- Teaching resources include press articles, audio and video documents (TV reports, film and series extracts) as well as the Internet.
- Regular personal work is required. Students must be curious and practise their English outside the classroom.

**Evaluation :**

Two-hour written test.(2/3)

Individual oral presentation in class.(1/3)

**Target :**

<b>Human sciences project</b>	<b>HUM05-PSH</b>
<b>Number of hours : 26.00 h</b>	<b>2.50 ECTS credit</b>
<b>TD : 26.00 h</b>	
<b>Reference Teacher(s) : ECHARD Philippe</b>	

**Objectives :**

Conduct a rigorous and synthetic reflection on a given topic dealing with one subject of interest developed by the Specialty Department. .

Learning outcomes expected:

- Knowing how to define a study subject and associate a relevant problematic.
  - Knowing how to find relevant information by using the resources available from the Internet
  - Knowing how to produce quality communication events and documents (written report, pwpt or prezi presentation, organization of professional meeting)
- Knowing how to manage a collective project: planning and coordinating actions to produce documents to be delivered within a given time-limit.

**Content :**

The students will make up teams and choose a topic that will be approved by the teacher. Their documentary research shall lead to the definition of a problematic and a written report (comprising a synthetic note + commented bibliography + abstract/summary) in accordance with academic requirements.

Methodological gain :

- documentary search on the net. Acquisition of ZOTERO software
- brainstorming techniques and heuristic approach
- problematic definition
- academic-type writing of report or bibliography
- project management technique

**Bibliography :**

available on-line through the teacher

**Requirements :**

**Organisation :**

Alternately methodology courses and progress report sessions of the team projects

**Evaluation :**

Continuous assessment :

- 1 written report comprising : 1 synthetic note + 1 commented bibliography + abstract/summary)
- 1 oral submission (with pwpt or prezi presentation)

**Target :**

<b>Sport and physical Education</b>	<b>HUM05-EPS</b>
<b>Number of hours : 24.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 24.00 h, TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**

<b>Music Studies</b>	<b>HUMF1-MUS</b>
<b>Number of hours : 25.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 25.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- working and communicating in a team
- cultural openness
- listening to others
- managing stress

Students have the opportunity to combine their studies with their passion for music. By joining two Jazz and Classical orchestras, they can continue their instrumental practice and also participate in a quality musical training course supervised by teachers from the Rennes Regional Conservatory. Through group practice, they will be able to develop their skills in listening, collaboration and their ability to adapt, all of which are essential to every kind of teamwork. They will participate actively in the cultural life of the school and frequently perform in public. Collective artistic practice within the institution will promote the personal development of the student.

**Content :**

2h collective lessons per week in the JAZZ et classical music ensembles with instrumental practice training in chamber music. Participation in festivals and organisation of cultural events at INSA. Several concerts and recitals over the year at INA and externally.

**Bibliography :**

Musical scores are distributed at the beginning of the year

**Requirements :**

Good instrumental ability, music studies in conservatory or school of music; ability to read music. Admission to the programme is based on dossier and an audition organised at the beginning of the year.

**Organisation :**

2 hours group practice per week

**Evaluation :**

validation without grade

**Target :**

INSA students, INP, Centrale/Supélec and external students

<b>Association membership &amp; responsibilities 1 credit - Diversity Mission</b>	<b>HUMF1-APES DIV</b>
<b>Number of hours : 60.00 h</b>	<b>1.00 ECTS credit</b>
<b>DIV : 7.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**



<b>Recherche Innovation</b>	<b>HUMF1- RI</b>
<b>Number of hours : 8.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 8.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>INNOVATION &amp; ENTREPRENEURSHIP</b>	<b>HUMF1- IE</b>
<b>Number of hours : 8.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 8.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

The aim of this module is to inspire future engineers and stimulate their creativity and initiative, by instilling a spirit of entrepreneurship.

Expected skills:

- observe and consider what exists to generate new ideas,
- make the most of the environment to challenge new concepts,
- communicate and federate around an innovative project.

**Content :**

Using a list of preselected events, the students build their exploration program and choose to attend 1 to 2 events over semester 5.

Students have an academic coach and regularly report on their progress.

**Bibliography :**

Provided during the course.

**Requirements :**

None.

**Organisation :**

Students are encouraged to identify technologies or inspiring trends by taking advantage of events dealing with innovation and entrepreneurship (tradeshows, conferences, etc.).

**Evaluation :**

Students write post-event reports focusing on inspiring aspects of their experiences.

**Target :**

**Semestre 6**

**Parcours FISP**

<b>1</b>	<b>DET06-1</b>		<b>Electronic Linear Systems</b>	<b>9.50</b>
	DET06-ALS	O	Analog Linear Systems	6.00
	DET06-EWAB	O	Electromagnetic Waves and Antennas - Basics	3.50
<b>2</b>	<b>DET06-2</b>		<b>Signal and Propagation</b>	<b>6.50</b>
	DET06-SSPB	O	Statistical signal processing	2.50
	DET06-COMSYS	O	Communication Systems	4.00
<b>3</b>	<b>DET06-3</b>		<b>Computer science and programmable logic</b>	<b>7.00</b>
	DET06-AMI	O	Architecture and microcontrollers	3.50
	DET06-DLS	O	Digital Linear Systems	2.50
	DET06-RES	O	Network : fom Ethernet to IP	1.00
<b>4</b>	<b>HUM06-ISP</b>		<b>Non-scientific syllabus S6</b>	<b>6.00</b>
	HUM06-ANGL	O	English	2.00
	HUM06-IMO	C	Introduction to Operational Management	1.50
	HUM06-IND	C	Introduction au Numérique Durable	1.50
	HUM06-IEB	C	Impact Environnemental des Batiments	1.50
	HUM06-SIM	C	BUSINESS SIMULATION GAME	1.50
	HUM06-EPS	O	Sport and physical Education	1.00
	HUMF2-ESP	C	Spanish	1.50
	HUMF2-CHI	C	Chinese	1.50
	HUMF2-ITA	C	Italian	1.50
	HUMF2-RUS	C	Russian	1.50
	HUMF2-JAP	C	Japanese	1.50
	HUMF2-ALL	C	German	1.50

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

<b>Analog Linear Systems</b>	<b>DET06-ALS</b>
<b>Number of hours : 77.00 h</b>	<b>6.00 ECTS credit</b>
<b>CM : 10.00 h, CM : 14.00 h, PR : 20.00 h, PR : 1.00 h, TD : 16.00 h, TP : 6.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**Objectives :**

- To be able to conceive and use simple and closed-loop linear systems essentially dedicated to filtering and/or signal transmission functions
- To know the main useful methods for analyzing the stability of a linear system
- To know how to conceive and study an electronic oscillator

**Content :**

- "1- Linear systems : integrated amplifiers. Perfect and real amplifiers. Matrix representation of amplifier characteristics.
- 2- Main transfer functions in linear filtering. Interest and applications of filtering in the domain of communications. Optimal filter for signal transmission. Butterworth, Bessel and Chebyshev norms. Approximation functions.
- 3- Closed-loop linear systems. Changes in the matrix characteristics of a linear system. Change in the functionalities. Performance improvement in terms of transmission and interchangeability.
- 4- Synthetic technical project over the entire module programme."

**Bibliography :**

J. Blot, électronique linéaire, cours avec exercices et travaux pratiques, Dunod.

**Requirements :**

"Linear electric circuit analysis, DET05-ELEC module;  
Special functions, DET05-MATP module."

**Organisation :**

**Evaluation :**

"Two-hour written examination (coeff. 2)  
Mark for course work (coeff. 2)  
Mark for practical work (coeff. 1)  
Mark for project work (coeff. 2)"

**Target :**

3rd year E&T students

<b>Electromagnetic Waves and Antennas - Basics</b>	<b>DET06-EWAB</b>
<b>Number of hours : 46.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 20.00 h, CM : 10.00 h, TD : 12.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : GILLARD Raphael</b>	

**Objectives :**

"The basics of electromagnetism from Maxwell's equations. Development of study methods for propagation and electromagnetic radiation in a free space. Analysis of reflection and refraction. Power budget and equivalent problems in EM.

The study of fundamental parameters of antennas."

**Content :**

"Part 1 : Electromagnetic propagation :

1. Maxwell's equations in free space and in material media.
2. Propagation of electromagnetic waves with and without loss; skin depth.
3. The plane wave and its properties. Wave polarisation.
4. Electromagnetic energy. Poynting's theorem.
5. Boundary conditions. Reflection and refraction at the interface between two media. Fresnel's formulas.
6. Unicity principle. Huygens' principle. Image theory.
7. Radiation from simple sources (dipole and aperture).

Part 2 : Fundamental parameters of antennas :

- 1- Impedance.
- 2- Radiation (gain, directivity, effective area, effective length, polarization).
- 3- Friis power transmission equation."

**Bibliography :**

""Electromagnetics fields Energy and waves (Chap II,IV,VII,VIII,IX,XI)"" , Leonard M.Magid, John Wiley Editor.

""Advanced engineering electromagnetics"" , C. A. Balanis, John Wiley Editor.

""Antenna Theory, Analysis and Design"" , C.A. Balanis, John Wiley Editor"

**Requirements :**

SRC05-WTLB

**Organisation :**

**Evaluation :**

"Two-hour written examination.

Bonus marks for coursework."

**Target :**

3rd year E&T

<b>Statistical signal processing</b>	<b>DET06-SSPB</b>
<b>Number of hours : 30.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 12.00 h, TD : 10.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

- "- To know how to identify and represent a random process (r.p.) according to the statistical and temporal dimensions
- To master the basic concepts needed to handle with random processes, i.e. statistical moments, statistical autocorrelation, covariance, temporal moments.
- To know the concepts of wide sense stationary and ergodic random processes.
- To know how to compute the power spectral density (PSD) of a stationary process
- To know how to determine the properties of filtered r.p. with an LTI system, in particular the second order properties
- To know the definition of wide sense cyclostationary process
- To know how to compute the PSD of linear modulations
- To know how to use the Chapman-Kolmogorov theorem for markovian processes"

**Content :**

- "- Probability basics
- discret/continuous random processes with discrete/continuous time. Definition of the statistical order k of a process
- Statistical moments, statistical autocorrelation. Temporal moments and temporal autocorrelation. Wide sense stationarity and ergodicity
- Filtering of random processes
- Cyclostationarity and power spectral density of linear modulation
- Markovian processes"

**Bibliography :**

Maurice Charbit, "Eléments de théorie du signal: les signaux aléatoires", Edition ellipses  
 Athanasios Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes, International Edition, 2002"

**Requirements :**

Signal processing basics : SRC05-SPB  
 Probability basics : DET05-PROBA

**Organisation :**

**Evaluation :**

1 written exam of 2H et 1 labwork exam of 1H.

**Target :**

3rd year E&T

<b>Communication Systems</b>	<b>DET06-COMSYS</b>
<b>Number of hours : 46.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 24.00 h, TD : 10.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**Objectives :**

- To know how to model and identify the various functions involved in a communication chain
- To know how to model and manipulate communication signals, in baseband and in passband
- To know the principles of signal transmission and the various strategies of carrier frequency transposition
- To know the various analogue and digital modulation forms
- To know how to assess the performance of a communication system in a noisy environment
- To know how to assess the spectral occupancy of a modulated signal

**Content :**

1. Communication Systems: general block diagrams, elementary functions, baseband and passband principles
2. Tools for the analysis of communication signals: analytic signal, complex envelope, noise model, power spectral density, signal to noise ratio
3. Analogue modulation schemes and carrier frequency transposition: linear and non-linear transposition, amplitude and angular modulation, coherent and non-coherent detection, spectral efficiency, processing gain
4. From analogue to digital communications: signal sampling and quantization, impulse modulations, line codes
5. Digital communications: symbol and mapping principles, constellation, throughput computation, spectral efficiency, modulation schemes."

**Bibliography :**

"Communications analogiques", D. Ventre, Ellipse

"Introduction aux communications numériques - Cours et exercices", M. Joindot, A. Glavieux, Dunod "

**Requirements :**

"Signal Processing - Basics, DET05-SPB  
Statistical Signal Processing, DET06-SSPB"

**Organisation :**

**Evaluation :**

Two-hour written examination (coeff. 2)  
Mark for practical work (coeff. 1)

**Target :**

3rd year E&T

<b>Architecture and microcontrollers</b>	<b>DET06-AMI</b>
<b>Number of hours : 44.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 20.00 h, PR : 12.00 h, TD : 4.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARTINI AUDREY</b>	

**Objectives :**

Being able to understand the internal structure of a processor and peripherals  
 Know how choosing a processor according to the specifications

**Content :**

"First part ( 10H lessons) :

Internal operations of a processor

Interfaces with memory and peripherals

Second part ((8H lessons, 4H TD, 8 TP) :

Illustration with STM32 Cortex M4 ( processor STM32F446)

Labs using the STM32

Third part ( 12H) :

Project-Labs with different peripherals and simple communications protocols

"

**Bibliography :**

"Architecture de l'Ordinateur. Robert Strandh- Dunod

Microcontrôleurs MSP430, cours Moodle, site Texas Instrument "

**Requirements :**

ESM05-LOG et ESM05-INFOC

**Organisation :**

**Evaluation :**

Mark for course work (coeff. 2)

Mark for project work (coeff. 1)

**Target :**

3rd year E&T



<b>Digital Linear Systems</b>	<b>DET06-DLS</b>
<b>Number of hours : 28.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 20.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LE MAGOAROU Luc</b>	

**Objectives :**

- To be able to model and manipulate digital linear systems, with a special focus on filtering applications
- To be able to study the time/frequency behavior of such systems and conclude on stability and causality
- To know how to use the Z transform tool
- To be able to recognize the various digital filter categories
- To know the main digital filter synthesis methods

**Content :**

1. Digital linear systems: discrete time impulse response, normalize frequency response, transfer function, stability, causality, block-diagram representation
2. Z transform tool: direct and inverse transform, properties, calculation rules and techniques
3. Analysis methods: utilization of the Z-transform, geometric approach through the zeros and poles plane
4. Digital filters: classification, RII and RIF filters, specific filter networks, filter conception, synthesis methods"

**Bibliography :**

"Traitement numérique des signaux - théorie et pratique", M. Bellanger, Dunod  
 Traitement numérique du signal - une introduction  
 , A.W.M. Van den Enden et N.A.M. Verhoeckx, Masson

**Requirements :**

"Signal Processing - Basics, DET05-SPB  
 Complex functions of complex variables, ESM05-ANAL"

**Organisation :**

**Evaluation :**

"Two-hour written examination (coeff. 2)  
 Short random exams during lectures to capitalize bonus marks. Mark for practical work (coeff. 1)"

**Target :**

3rd year E&T

<b>Network : fom Ethernet to IP</b>	<b>DET06-RES</b>
<b>Number of hours : 10.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 8.00 h, TP : 2.00 h</b>	
<b>Reference Teacher(s) : FARAH Joumana</b>	

**Objectives :**

OSI model, N2: Ethernet, N3 : IP V4.

**Content :**

Part 1 : OSI model and TCP/IP

Part 2 : Ethernet , CSMA/CD, network equipments

Part 3 : IP and mechanisms ( ARP), students can register on Fun platform

**Bibliography :**

On line platform for education FUN

:<https://www.fun-mooc.fr/courses/course-v1:MinesTelecom+04003+session06/about>, lesson Principes des réseaux de données

**Requirements :**

**Organisation :**

**Evaluation :**

1 exam - 2H.

**Target :**

<b>English</b>	<b>HUM06-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**Objectives :**

Improve expression, comprehension and interaction skills within everyday contexts, with special emphasis on professional and social life.

Language Objectives

Obtain or reinforce B2 level (as required for graduation and defined by CECRL )

**Content :**

-Action-oriented approach - learning by doing :

students have to listen and speak, write documents while using their problem-solving, reasoning, arguing, and demonstrating capabilities, in an articulate manner.

-Expressing oneself accurately by a rigorous use of syntax and phonology :

Activities requiring creative and reactive skills, ranging from debating, role-playing, individual oral presentations (PowerPoint), projects ... are based on scientific topics and current events.

-Building up specific skills in connection with the working world :

- writing e-mails
- conducting telephone conversations
- technical English
- intercultural contexts

In addition to the English course, a 90-minute remedial course takes place every week (over 10 weeks), in which students can update their various skills (listening and reading, writing, speaking and interacting) in small groups. Remedial classes are compulsory for all students that did poorly in their start-of-term placement test - and optional for those who feel they need to attend. There is no specific assessment for this course.

**Bibliography :**

- Dictionnaire Robert et Collins bilingue, or Collins Cobuild unilingue
- English Grammar in Use (Cambridge University Press)

**Requirements :**

A good command of the STPI curriculum is essential : B1/B2

**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 students to work in a stimulating environment.

-Teaching resources include press articles, audio and video documents (TV reports, film and series extracts) as well as the Internet.

-Regular personal work is required. Students must be curious and practise their English outside the classroom.

**Evaluation :**

Two-hour written test (50%)

Individual oral presentation (50%)

**Target :**

<b>Introduction to Operational Management</b>	<b>HUM06-IMO</b>
<b>Number of hours : 24.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TD : 10.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : SORRE Frederic</b>	

**Objectives :**

A company in its field of application must adopt methods associated with tools, allowing it to manage value creation. This module is an introduction to the notion of operational management (production management, quality management, continuous improvement process). This module should enable students to develop a systematic overview of company organisation.

**Content :**

**I - INTRODUCTION:**

The aim of a company, changes in socio-economic context, operational excellence, typological analysis, notion of flow and process.

**II - PERMANENT PROGRESS:**

Notion of waste, the basic tools, processes of problem solving, management of materials.

**III – PLANNING AND PILOTING FLOWS:**

Planning for component requirement needs, principles of MRP2 (SOP / PIC, MPS / PDP, MRP / CBN), load-capacity management, Concept of ERP.

**IV – PLANNING IN THE WORLD OF VUCA: Presentation of DDMRP methodology.**

**V – OPERATIONAL MANAGEMENT:**

Operations Management, Theory of Constraints, Kanban Methods

**VI - NOTION OF QUALITY :**

Quality tools; statistical control of processes

**Bibliography :**

Gestion de la production - Blondel - DUNOD  
 La gestion de production - Bénassy - HERMES  
 Contrôle de la qualité - Jaupi - DUNOD  
 Lean Management - Hohmann - Eyrolles

**Requirements :**

**Organisation :**

**Evaluation :**

1 written test (2h) – continuous assessment in PR

**Target :**

<b>Introduction au Numérique Durable</b>	<b>HUM06-IND</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TA : 5.00 h, TD : 6.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Impact Environnemental des Batiments</b>	<b>HUM06-IEB</b>
<b>Number of hours : 24.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 24.00 h</b>	
<b>Reference Teacher(s) : SOMJA Hugues</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>BUSINESS SIMULATION GAME</b>	<b>HUM06-SIM</b>
<b>Number of hours : 16.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 16.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**Objectives :**

This course focuses on the complexity of the decision-making process in a company.

Main learning outcomes:

- Understanding information relative to marketing and finance
- The ability to use specific tools and vocabulary in the field of management
- Understanding the importance of teamwork: making collective decisions and producing the expected work in time

**Content :**

The course is mainly focused around a Business simulation, which empowers participants to run their own virtual businesses. Just like in real life, the teams compete against each other in order to gain market shares. The right decisions lead to success while the wrong ones engender invaluable problem solving experiences. The learning process becomes efficient and fun, and allows “learning by doing” as well as “learning from mistakes”.

As an outcome of the simulation exercise, participants will fully comprehend the different aspects of the marketing decision making process, their relationship with each other, and their impact on the company’s overall results. In addition, participants will gain invaluable experience in teamwork and problem solving.

The simulation is based on an online platform that allows students to make some decisions outside the classroom.

**Bibliography :**

Provided during the course

**Requirements :**

None

**Organisation :**

2 hours per week

**Evaluation :**

Continuous assessment (collective work)

**Target :**

<b>Sport and physical Education</b>	<b>HUM06-EPS</b>
<b>Number of hours : 24.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**



<b>Spanish</b>	<b>HUMF2-ESP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : AMARGOS GUILLERAY Marine</b>	

**Objectives :**

- Practising and strengthening of one's knowledge in the Spanish language and culture (Spanish culture, Spanish and Latin- American civilizations, societal developments).
- How to manage team projects
- Acquiring, developing know-how and knowledge in a professional and multicultural environment
- Understanding social, technological and economical challenges in Spanish-speaking countries.

**Content :**

**Bibliography :**

1. PASTOR Enrique and PROST Gisèle : "La grammaire active de l'espagnol", Le livre de poche, collection Les Langues modernes.
2. BECHERELLE, "El arte de conjugar en espanol", Hatier.
3. Larousse bilingual dictionary, Le Grand Dictionnaire de Garcia y Pelayo et Testas, Dictionary Hispano Bordas.
4. "Passez-moi l'expression en espagnol", Belin.
5. "El espanol en la prensa", Belin.

**Requirements :**

B1 level

**Organisation :**

- Reinforcing grammar / conjugation
- Reading and oral comprehension
- Writing and speaking (debates, drama).

Advice : Read in Spanish : contemporary novels, comics (Tintin, Astérix, Mafalda), magazines (Cambio 16, Epoca, Vocablo and Don Balon) available at the library.

Visit the Internet pages of the Spanish and Latin-American newspapers (lavanguardia.es, elpais.es...)

Listen to Spanish National Radio programmes (RNE) on Internet.

Watch TV programmes on RTVE.es.

Read tourist guides on Spanish-speaking countries available at the library.

**Evaluation :**

15 mn face to face oral

**Target :**

3rd, 4th, 5th year

<b>Chinese</b>	<b>HUMF2-CHI</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Objectives, aims:

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

To acquire the basics of the Chinese language in terms of grammatical structures and essential vocabulary  
 Comprehension, expression, pronunciation  
 Use of the language in everyday contexts

**Content :**

Oral skills:

Corrective Phonetics corrective (pinyin system),  
 Listening and analysis of simple texts and complex phrases  
 Oral exercises (peer learning / learners with teacher)  
 Learning new characters (pronunciation and tonal stress)

Writing skills:

Translation (Chinese to French and French to Chinese)  
 Written production of simple texts and complex phrases  
 Learning and consolidation of grammatical and lexical structures for oral and written production,  
 Learning new characters (order of strokes, keys),  
 Reading and analysis of texts, text commentary

**Bibliography :**

1. Le chinois comme en Chine, Bernard Allenci, Presses Universitaires de Rennes, 2009\_2. Le chinois contemporain, WU Zhongwei, Sinolingua, 2010\_3. Faire l'expérience du chinois, ZHANG Rumei, Ai Xin, Higher Education Press, 2006

Other tools will complement these basic learning manuals in order to provide students with a wide range of practical exercises

**Requirements :**

Chinois 1 : none

Chinois 2 : to have attended lessons in Chinois 1

Chinois 3 : to have attended lessons in Chinois 2

**Organisation :**

Reading lesson text materials ( in characters), rewriting new characters, applied exercises on grammatical points, lexical points and morphology

Exercises in translation: from Chinese to French and French to Chinese

19 h TU equivalent in STPI

**Evaluation :**

S2 : Oral

**Target :**

Engineering students

<b>Italian</b>	<b>HUMF2-ITA</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : KERSUSAN Sylvia</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Level 1 Beginner :

To introduce the Italian language and Italian culture, to express the fundamentals in writing and orally

Level 2 Advanced Beginner:

By the end of the course, students should be able to converse and write in Italian

Level 3 Intermediate:

To enable students to develop further on themes relating to art, civilisation, literature and cinema

**Content :**

Oral expression and comprehension:

reading with the teacher's guidance on phonetic and grammatical corrections

reading situations in the text, viewing films and reading literary texts and press articles

Written expression and Comprehension:

completing text-based exercises with particular attention to difficulties

summarising situations in available texts and films studied in class

**Bibliography :**

La lingua italiana per Stranieri 1°, 2°, 3°P K.Katerinov

La prova orale 1,2,3 T.Marin

Texts taken from newspapers and Italian magazines, films by famous film directors

**Requirements :**

Level 1 Beginner: none

Level 2 Advanced Beginner : to have attended the Italian Beginner lessons

Level 3 Intermediate: to have a good knowledge of the Italian language

**Organisation :**

1h30 of face-face lessons per week; 21h per semester

Personal Study: 14h

To read the photocopied texts provided

**Evaluation :**

S2 : Oral

**Target :**

Engineering students

<b>Russian</b>	<b>HUMF2-RUS</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

According to level: Beginners (A1), Intermediate (A2/B1), Advanced (B1-B2). Help the students to progress autonomously.

**Content :**

Written and oral communication. Firstly in everyday life situations, and secondly in other fields such as professional topics.

- Films and book extracts are used as a learning aid
- Individual exercises and group work, oral presentations for intermediates
- Grammar
- Cinema, literature and civilization.

**Bibliography :**

**Requirements :**

**Organisation :**

Classes take place at SUPELEC (Campus de Beaulieu)

**Evaluation :**

Final grade (overseen by SUPELEC).

**Target :**

<b>Japanese</b>	<b>HUMF2-JAP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Niveau débutant (A1):

- awareness of particularities (phonetics, syntax)
- discovery of Japanese culture, traditions, customs
- learning the two systems of writing (Hiragana and Katakana)
- to be able to use spoken Japanese in everyday situations

Intermediate level (A2):

- introduction ideogrammes (60 kanji)
- reading simple texts (with Manga, etc...)
- writing simple texts
- to be able to use spoken Japanese in everyday situations

Advanced level (B1, B2):

- learning kanji (60-200)
- acquiring the four skills (written and oral comprehension, written and oral expression) for travel or study in Japan

**Content :**

Level 1 Beginner (A1):

- Perfecting Hiragana et Katakana - reading Manga
- Lesson 5: speaking about pastimes
- Lesson 6: using transport
- Lesson 7: shopping
- Lesson 8: expressing feelings

Level 2 Beginner (A2):

- learning 30 kanji - reading Manga
- basic Grammar
- reading and writing simple texts
- learning how to communicate in everyday situations

Intermediate level (B1, B2) :

- learning to use more than 30 kanji
- reading Manga
- acquiring the four skills (written and oral comprehension, written and oral expression)

**Bibliography :**

Level 1 Beginner (A1): Margot, 3A Network, to be published, Japan.

Level 2 Beginner (A2): Daichi, 1, 3A Network, 2008, Japan.

Level 3 Intermediate (B1, B2): Minna no Nihongo, I et II, 3A Network, 1998, Japan.

+ Satoru Koyama, J. Bridge, Bonjinsha, 2007, Japan.

**Requirements :**

Level 1: none.

Level 2: to have taken Level A1 Beginner course

Level 3: to have taken Beginner Levels A1 and A2

**Organisation :**

The teaching follows the TU format.

In each session there is an explanation of the structures which are then illustrated by examples and by exercises and conversation which the students participate in.

**Evaluation :**

S2 : Oral

**Target :**

Engineering students

<b>German</b>	<b>HUMF2-ALL</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

To consolidate secondary school level learning outcomes

To attain, as a basic minimum, the B1 level by the end of the first cycle

To practise written and oral comprehension through the use of contemporary supports and multimedia

To develop level of oral expression through exercises in small groups and class discussions

To demonstrate and perfect your skills in German through project work

Support for foreign exchange and work placements

**Content :**

Contents:

- Exercises to practise spoken German for everyday situations and professional life
- Study of newspaper articles, broadcasts, videos
- Study of current affairs (politics, economics, sociology and culture) in Germanophone countries
- Introduction to economic and professional German
- Grammar revision
- Cultural openness (film studies, exhibitions, music)

**Bibliography :**

(available in the INSA Rennes library):

- DUDEN Bilingual Dictionary (German-French/French-German)
- Grammatik Aktiv A1-B1, Cornelsen (mit Audio CD)\_ Schritte-Übungsgrammatik A1-B1, Hueber-Verlag
- Übungsgrammatik für die Grundstufe, Hueber-Verlag (Moodle) - Na also!
- Waltraud Legros, Ellipses\_ - Manuel : Menschen hier, Hueber-Verlag
- Deutsch perfekt (periodical) -
- Deutsche Welle/ ZDF logo (web) -
- multimedia supports (web)

**Requirements :**

Intermediate German: B1 level

**Organisation :**

1h30 per week; 21h face-to-face lessons per semester

Personal Study time: 14h

Total: 35 h

Students are encouraged to regularly read news articles in German and to view videos and film series in addition to work assigned between lessons.

**Evaluation :**

S2 : Oral

**Target :**

Engineering students

**Semestre 6**

**Parcours Formation Initiale E&T**

<b>1</b>	<b>DET06-1</b>		<b>Electronic Linear Systems</b>	<b>9.50</b>
	DET06-ALS	O	Analog Linear Systems	6.00
	DET06-EWAB	O	Electromagnetic Waves and Antennas - Basics	3.50
<b>2</b>	<b>DET06-2</b>		<b>Signal and Propagation</b>	<b>6.50</b>
	DET06-SSPB	O	Statistical signal processing	2.50
	DET06-COMSYS	O	Communication Systems	4.00
<b>3</b>	<b>DET06-3</b>		<b>Computer science and programmable logic</b>	<b>7.00</b>
	DET06-AMI	O	Architecture and microcontrollers	3.50
	DET06-DLS	O	Digital Linear Systems	2.50
	DET06-RES	O	Network : fom Ethernet to IP	1.00
<b>4</b>	<b>HUM06</b>		<b>Non-scientific syllabus S6</b>	<b>7.00</b>
	HUM06-IMO	C	Introduction to Operational Management	1.50
	HUM06-IND	C	Introduction au Numérique Durable	1.50
	HUM06-ANGL	O	English	2.00
	HUM06-SIM	O	BUSINESS SIMULATION GAME	1.50
	HUM06-EPS	O	Sport and physical Education	1.00
	HUM06-PPI	O	Professional Project	1.00
<b>9</b>	<b>HUMF2-ELSA Mus</b>		<b>Music with Studies</b>	<b>1.00</b>
	HUMF2-MUS	C	Music Studies	1.00

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



<b>Analog Linear Systems</b>	<b>DET06-ALS</b>
<b>Number of hours : 77.00 h</b>	<b>6.00 ECTS credit</b>
<b>CM : 10.00 h, CM : 14.00 h, PR : 20.00 h, PR : 1.00 h, TD : 16.00 h, TP : 6.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**Objectives :**

- To be able to conceive and use simple and closed-loop linear systems essentially dedicated to filtering and/or signal transmission functions
- To know the main useful methods for analyzing the stability of a linear system
- To know how to conceive and study an electronic oscillator

**Content :**

- "1- Linear systems : integrated amplifiers. Perfect and real amplifiers. Matrix representation of amplifier characteristics.
- 2- Main transfer functions in linear filtering. Interest and applications of filtering in the domain of communications. Optimal filter for signal transmission. Butterworth, Bessel and Chebyshev norms. Approximation functions.
- 3- Closed-loop linear systems. Changes in the matrix characteristics of a linear system. Change in the functionalities. Performance improvement in terms of transmission and interchangeability.
- 4- Synthetic technical project over the entire module programme."

**Bibliography :**

J. Blot, électronique linéaire, cours avec exercices et travaux pratiques, Dunod.

**Requirements :**

"Linear electric circuit analysis, DET05-ELEC module;  
Special functions, DET05-MATP module."

**Organisation :**

**Evaluation :**

"Two-hour written examination (coeff. 2)  
Mark for course work (coeff. 2)  
Mark for practical work (coeff. 1)  
Mark for project work (coeff. 2)"

**Target :**

3rd year E&T students

<b>Electromagnetic Waves and Antennas - Basics</b>	<b>DET06-EWAB</b>
<b>Number of hours : 46.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 20.00 h, CM : 10.00 h, TD : 12.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : GILLARD Raphael</b>	

**Objectives :**

"The basics of electromagnetism from Maxwell's equations. Development of study methods for propagation and electromagnetic radiation in a free space. Analysis of reflection and refraction. Power budget and equivalent problems in EM.

The study of fundamental parameters of antennas."

**Content :**

"Part 1 : Electromagnetic propagation :

1. Maxwell's equations in free space and in material media.
2. Propagation of electromagnetic waves with and without loss; skin depth.
3. The plane wave and its properties. Wave polarisation.
4. Electromagnetic energy. Poynting's theorem.
5. Boundary conditions. Reflection and refraction at the interface between two media. Fresnel's formulas.
6. Unicity principle. Huygens' principle. Image theory.
7. Radiation from simple sources (dipole and aperture).

Part 2 : Fundamental parameters of antennas :

- 1- Impedance.
- 2- Radiation (gain, directivity, effective area, effective length, polarization).
- 3- Friis power transmission equation."

**Bibliography :**

""Electromagnetics fields Energy and waves (Chap II,IV,VII,VIII,IX,XI)"" , Leonard M.Magid, John Wiley Editor.

""Advanced engineering electromagnetics"" , C. A. Balanis, John Wiley Editor.

""Antenna Theory, Analysis and Design"" , C.A. Balanis, John Wiley Editor"

**Requirements :**

SRC05-WTLB

**Organisation :**

**Evaluation :**

"Two-hour written examination.

Bonus marks for coursework."

**Target :**

3rd year E&T

<b>Statistical signal processing</b>	<b>DET06-SSPB</b>
<b>Number of hours : 30.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 12.00 h, TD : 10.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

- "- To know how to identify and represent a random process (r.p.) according to the statistical and temporal dimensions
- To master the basic concepts needed to handle with random processes, i.e. statistical moments, statistical autocorrelation, covariance, temporal moments.
- To know the concepts of wide sense stationary and ergodic random processes.
- To know how to compute the power spectral density (PSD) of a stationary process
- To know how to determine the properties of filtered r.p. with an LTI system, in particular the second order properties
- To know the definition of wide sense cyclostationary process
- To know how to compute the PSD of linear modulations
- To know how to use the Chapman-Kolmogorov theorem for markovian processes"

**Content :**

- "- Probability basics
- discret/continuous random processes with discrete/continuous time. Definition of the statistical order k of a process
- Statistical moments, statistical autocorrelation. Temporal moments and temporal autocorrelation. Wide sense stationarity and ergodicity
- Filtering of random processes
- Cyclostationarity and power spectral density of linear modulation
- Markovian processes"

**Bibliography :**

Maurice Charbit, "Eléments de théorie du signal: les signaux aléatoires", Edition ellipses  
 Athanasios Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes, International Edition, 2002"

**Requirements :**

Signal processing basics : SRC05-SPB  
 Probability basics : DET05-PROBA

**Organisation :**

**Evaluation :**

1 written exam of 2H et 1 labwork exam of 1H.

**Target :**

3rd year E&T

<b>Communication Systems</b>	<b>DET06-COMSYS</b>
<b>Number of hours : 46.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 24.00 h, TD : 10.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**Objectives :**

- To know how to model and identify the various functions involved in a communication chain
- To know how to model and manipulate communication signals, in baseband and in passband
- To know the principles of signal transmission and the various strategies of carrier frequency transposition
- To know the various analogue and digital modulation forms
- To know how to assess the performance of a communication system in a noisy environment
- To know how to assess the spectral occupancy of a modulated signal

**Content :**

1. Communication Systems: general block diagrams, elementary functions, baseband and passband principles
2. Tools for the analysis of communication signals: analytic signal, complex envelope, noise model, power spectral density, signal to noise ratio
3. Analogue modulation schemes and carrier frequency transposition: linear and non-linear transposition, amplitude and angular modulation, coherent and non-coherent detection, spectral efficiency, processing gain
4. From analogue to digital communications: signal sampling and quantization, impulse modulations, line codes
5. Digital communications: symbol and mapping principles, constellation, throughput computation, spectral efficiency, modulation schemes."

**Bibliography :**

- "Communications analogiques", D. Ventre, Ellipse  
 "Introduction aux communications numériques - Cours et exercices", M. Joindot, A. Glavieux, Dunod "

**Requirements :**

- "Signal Processing - Basics, DET05-SPB  
 Statistical Signal Processing, DET06-SSPB"

**Organisation :**

**Evaluation :**

- Two-hour written examination (coeff. 2)  
 Mark for practical work (coeff. 1)

**Target :**

3rd year E&T

<b>Architecture and microcontrollers</b>	<b>DET06-AMI</b>
<b>Number of hours : 44.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 20.00 h, PR : 12.00 h, TD : 4.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARTINI AUDREY</b>	

**Objectives :**

Being able to understand the internal structure of a processor and peripherals  
 Know how choosing a processor according to the specifications

**Content :**

"First part ( 10H lessons) :

Internal operations of a processor

Interfaces with memory and peripherals

Second part ((8H lessons, 4H TD, 8 TP) :

Illustration with STM32 Cortex M4 ( processor STM32F446)

Labs using the STM32

Third part ( 12H) :

Project-Labs with different peripherals and simple communications protocols

"

**Bibliography :**

"Architecture de l'Ordinateur. Robert Strandh- Dunod

Microcontrôleurs MSP430, cours Moodle, site Texas Instrument "

**Requirements :**

ESM05-LOG et ESM05-INFOC

**Organisation :**

**Evaluation :**

Mark for course work (coeff. 2)

Mark for project work (coeff. 1)

**Target :**

3rd year E&T

<b>Digital Linear Systems</b>	<b>DET06-DLS</b>
<b>Number of hours : 28.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 20.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LE MAGOAROU Luc</b>	

**Objectives :**

- To be able to model and manipulate digital linear systems, with a special focus on filtering applications
- To be able to study the time/frequency behavior of such systems and conclude on stability and causality
- To know how to use the Z transform tool
- To be able to recognize the various digital filter categories
- To know the main digital filter synthesis methods

**Content :**

1. Digital linear systems: discrete time impulse response, normalize frequency response, transfer function, stability, causality, block-diagram representation
2. Z transform tool: direct and inverse transform, properties, calculation rules and techniques
3. Analysis methods: utilization of the Z-transform, geometric approach through the zeros and poles plane
4. Digital filters: classification, RII and RIF filters, specific filter networks, filter conception, synthesis methods"

**Bibliography :**

"Traitement numérique des signaux - théorie et pratique", M. Bellanger, Dunod  
 Traitement numérique du signal - une introduction  
 , A.W.M. Van den Enden et N.A.M. Verhoecckx, Masson

**Requirements :**

"Signal Processing - Basics, DET05-SPB  
 Complex functions of complex variables, ESM05-ANAL"

**Organisation :**

**Evaluation :**

"Two-hour written examination (coeff. 2)  
 Short random exams during lectures to capitalize bonus marks. Mark for practical work (coeff. 1)"

**Target :**

3rd year E&T

<b>Network : fom Ethernet to IP</b>	<b>DET06-RES</b>
<b>Number of hours : 10.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 8.00 h, TP : 2.00 h</b>	
<b>Reference Teacher(s) : FARAH Joumana</b>	

**Objectives :**

OSI model, N2: Ethernet, N3 : IP V4.

**Content :**

Part 1 : OSI model and TCP/IP

Part 2 : Ethernet , CSMA/CD, network equipments

Part 3 : IP and mechanisms ( ARP), students can register on Fun platform

**Bibliography :**

On line platform for education FUN

:<https://www.fun-mooc.fr/courses/course-v1:MinesTelecom+04003+session06/about>, lesson Principes des réseaux de données

**Requirements :**

**Organisation :**

**Evaluation :**

1 exam - 2H.

**Target :**

<b>Introduction to Operational Management</b>	<b>HUM06-IMO</b>
<b>Number of hours : 24.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TD : 10.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : SORRE Frederic</b>	

**Objectives :**

A company in its field of application must adopt methods associated with tools, allowing it to manage value creation. This module is an introduction to the notion of operational management (production management, quality management, continuous improvement process). This module should enable students to develop a systematic overview of company organisation.

**Content :**

**I - INTRODUCTION:**

The aim of a company, changes in socio-economic context, operational excellence, typological analysis, notion of flow and process.

**II - PERMANENT PROGRESS:**

Notion of waste, the basic tools, processes of problem solving, management of materials.

**III – PLANNING AND PILOTING FLOWS:**

Planning for component requirement needs, principles of MRP2 (SOP / PIC, MPS / PDP, MRP / CBN), load-capacity management, Concept of ERP.

**IV – PLANNING IN THE WORLD OF VUCA: Presentation of DDMRP methodology.**

**V – OPERATIONAL MANAGEMENT:**

Operations Management, Theory of Constraints, Kanban Methods

**VI - NOTION OF QUALITY :**

Quality tools; statistical control of processes

**Bibliography :**

Gestion de la production - Blondel - DUNOD  
 La gestion de production - Bénassy - HERMES  
 Contrôle de la qualité - Jaupi - DUNOD  
 Lean Management - Hohmann - Eyrolles

**Requirements :**

**Organisation :**

**Evaluation :**

1 written test (2h) – continuous assessment in PR

**Target :**



<b>Introduction au Numérique Durable</b>	<b>HUM06-IND</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 10.00 h, TA : 5.00 h, TD : 6.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>English</b>	<b>HUM06-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**Objectives :**

Improve expression, comprehension and interaction skills within everyday contexts, with special emphasis on professional and social life.

Language Objectives

Obtain or reinforce B2 level (as required for graduation and defined by CECRL )

**Content :**

-Action-oriented approach - learning by doing :

students have to listen and speak, write documents while using their problem-solving, reasoning, arguing, and demonstrating capabilities, in an articulate manner.

-Expressing oneself accurately by a rigorous use of syntax and phonology :

Activities requiring creative and reactive skills, ranging from debating, role-playing, individual oral presentations (PowerPoint), projects ... are based on scientific topics and current events.

-Building up specific skills in connection with the working world :

- writing e-mails
- conducting telephone conversations
- technical English
- intercultural contexts

In addition to the English course, a 90-minute remedial course takes place every week (over 10 weeks), in which students can update their various skills (listening and reading, writing, speaking and interacting) in small groups. Remedial classes are compulsory for all students that did poorly in their start-of-term placement test - and optional for those who feel they need to attend. There is no specific assessment for this course.

**Bibliography :**

- Dictionnaire Robert et Collins bilingue, or Collins Cobuild unilingue
- English Grammar in Use (Cambridge University Press)

**Requirements :**

A good command of the STPI curriculum is essential : B1/B2

**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 students to work in a stimulating environment.

-Teaching resources include press articles, audio and video documents (TV reports, film and series extracts) as well as the Internet.

-Regular personal work is required. Students must be curious and practise their English outside the classroom.

**Evaluation :**

Two-hour written test (50%)

Individual oral presentation (50%)

**Target :**

<b>BUSINESS SIMULATION GAME</b>	<b>HUM06-SIM</b>
<b>Number of hours : 16.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 16.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**Objectives :**

This course focuses on the complexity of the decision-making process in a company.

Main learning outcomes:

- Understanding information relative to marketing and finance
- The ability to use specific tools and vocabulary in the field of management
- Understanding the importance of teamwork: making collective decisions and producing the expected work in time

**Content :**

The course is mainly focused around a Business simulation, which empowers participants to run their own virtual businesses. Just like in real life, the teams compete against each other in order to gain market shares. The right decisions lead to success while the wrong ones engender invaluable problem solving experiences. The learning process becomes efficient and fun, and allows “learning by doing” as well as “learning from mistakes”.

As an outcome of the simulation exercise, participants will fully comprehend the different aspects of the marketing decision making process, their relationship with each other, and their impact on the company’s overall results. In addition, participants will gain invaluable experience in teamwork and problem solving.

The simulation is based on an online platform that allows students to make some decisions outside the classroom.

**Bibliography :**

Provided during the course

**Requirements :**

None

**Organisation :**

2 hours per week

**Evaluation :**

Continuous assessment (collective work)

**Target :**

<b>Sport and physical Education</b>	<b>HUM06-EPS</b>
<b>Number of hours : 24.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**

<b>Professional Project</b>	<b>HUM06-PPI</b>
<b>Number of hours : 6.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 6.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Third Year PPI aims at training students to the job interview, thanks to specialits in Human Ressources.

**Content :**

**Bibliography :**

**Requirements :**

Being able to write a CV and cover letter

**Organisation :**

The course is organised as follows :

- First course PPI third year- group of 24 to 28 students
- The job interview as seen by the HR : goals, expectations, proceeding of the interviews, ...

Second course PPI third year-group of 12 to 14 students

How to get ready for an interview?

Tests  
Trailer

Third course PPI third year-group of 4 or 5 students  
mock job interviews

The contributors for this course are professionals in Human Resources

- Advisors in Human Resources in recruitment offices
- Responsible for Human Resources in companies

**Evaluation :**

A mark will be given by the contributor

**Target :**

All the 3rd-year-students

<b>Music Studies</b>	<b>HUMF2-MUS</b>
<b>Number of hours : 25.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 25.00 h, TD : 25.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Targeted skills :

- working and communicating in a team
- cultural openness
- listening to others
- managing stress

Students have the opportunity to combine their studies with their passion for music. By joining two Jazz and Classical orchestras, they can continue their instrumental practice and also participate in a quality musical training course supervised by teachers from the Rennes Regional Conservatory. Through group practice, they will be able to develop their skills in listening, collaboration and their ability to adapt, all of which are essential to every kind of teamwork. They will participate actively in the cultural life of the school and frequently perform in public. Collective artistic practice within the institution will promote the personal development of the student

**Content :**

2h collective lessons per week in the JAZZ et classical music ensembles with instrumental practice training in chamber music. Participation in festivals and organisation of cultural events at INSA. Several concerts and recitals over the year at INA and externally.

**Bibliography :**

Musical scores are distributed at the beginning of the year

**Requirements :**

Good instrumental ability, music studies in conservatory or school of music; ability to read music. Admission to the programme is based on dossier and an audition organised at the beginning of the year.

**Organisation :**

2 hours group practice per week

**Evaluation :**

validation without grade

**Target :**

INSA students, INP, Centrale/Supélec and external students

**Semestre 7**

**Parcours FISP**

<b>1</b>	<b>DET07-1</b>		<b>Electronic and Systems</b>	<b>7.50</b>
	DET07-ESNL	O	Non-Linear Electronic Systems	4.00
	DET07-DSP	O	Digital Signal Processing	2.00
	DET07-CDC	C	CDC Project	1.50
	DET07-RECH	C	Research & Innovation Project	1.50
<b>2</b>	<b>DET07-2</b>		<b>Signal Processing</b>	<b>6.50</b>
	DET07-DETI	O	Detection and estimation / Information Theory&Coding	4.50
	DET07-RADIO1	O	Radiocommunications Basics	2.00
<b>3</b>	<b>DET07-3</b>		<b>Communications</b>	<b>6.00</b>
	DET07-MB	O	Micro-ondes - Bases / Microwave Basics	2.50
	DET07-CNUM1	O	Digital Communications I	3.50
<b>4</b>	<b>DET07-4</b>		<b>Design Tools</b>	<b>4.00</b>
	DET07-VHDL	O	VHDL	2.00
	DET07-INFOC++	O	C++ Object Oriented Programming	2.00
<b>5</b>	<b>HUM07-ISP</b>		<b>Non-scientific syllabus S7</b>	<b>4.50</b>
	HUM07-ANGL	O	English	2.00
	HUM07-EPS	O	Sport and physical education	1.00
	HUMF1-ALL	C	German: Confirmed Level	1.50
	HUMF1-ESP	C	Spanish	1.50
	HUMF1-CHI	C	Chinese	1.50
	HUMF1-JAP	C	Japanese	1.50
	HUMF1-RUS	C	Russian	1.50

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

<b>Non-Linear Electronic Systems</b>	<b>DET07-ESNL</b>
<b>Number of hours : 52.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 4.00 h, CM : 18.00 h, TD : 10.00 h, TP : 16.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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), DET06-SL module.

**Organisation :**

Revision of class notes and practical exercises. Problem solving.

**Evaluation :**

1 two-hour written examination.

Mark for practical work

**Target :**

4 E&T



<b>Digital Signal Processing</b>	<b>DET07-DSP</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 8.00 h, TD : 8.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARTINI AUDREY</b>	

**Objectives :**

Digital signal processing. Use case : STM32F446 and DSPC64x

**Content :**

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

**Bibliography :**

"Traité d'électricité, d'électronique et d'électrotechnique - J.D. CHATELAIN et R. DESSOULAVY - Dunod.  
 Traitement numérique du signal - Gérard Blanchet - Hermes  
 Ingénierie des systèmes à microprocesseurs - Eric Martin et J-I. Philippe - CNET Collections Techniques"

**Requirements :**

DET06-AMI, ESM05-LOG

**Organisation :**

**Evaluation :**

Practice and 1 examination of 1H

**Target :**

4E&T

<b>CDC Project</b>	<b>DET07-CDC</b>
<b>Number of hours : 10.00 h</b>	<b>1.50 ECTS credit</b>
<b>PR : 10.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**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 :**

**Requirements :**

**Organisation :**

**Evaluation :**

Home work

**Target :**

4 E&T

<b>Research &amp; Innovation Project</b>	<b>DET07-RECH</b>
<b>Number of hours : 8.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 8.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

Beginning of the research project proposed to the student: knowledge and skills improvement necessary for its realization (training with the supervisor and/or in autonomy, bibliographic study, first examples, etc.); first simulations and/or characterizations of the studied systems, etc.

**Content :**

Individual work on a research and innovation subject proposed by a researcher from the IETR laboratory. The work is carried out remotely or in the premises of the IETR on sessions dedicated to the DET07-CDC module for other students and on other times of availability.

**Bibliography :**

Function of the proposed research topic. The first elements of the bibliography will be provided by the project supervisor.

**Requirements :**

**Organisation :**

**Evaluation :**

A grade will be awarded by the project supervisor according to the work done and/or a progress report.

**Target :**

4th year E&T students (=1st year of Master degree)  
4 E&T

Detection and estimation / Information Theory&Coding	DET07-DETIC
Number of hours : 58.00 h	4.50 ECTS credit
CM : 20.00 h, CM : 20.00 h, TD : 8.00 h, TD : 4.00 h, TD : 6.00 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. Benedetto, E. Biglieri, V. Castellani, ""Digital transmission theory"", Prentice Hall International Editions."

**Requirements :**

DET05-PROBA, DET05-MATP, DET06-SSPB, SRC06-COMSYS modules

**Organisation :**

Revision of lecture and practical work notes

**Evaluation :**

2 two-hour written examinations.

**Target :**

4 E&T students

<b>Radiocommunications Basics</b>	<b>DET07-RADIO1</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 20.00 h, TD : 8.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

DET05-WTLB (Waves and Transmission Lines Basics)  
DET06-EWAB (Electromagnetic Waves and Antennas Basics)

**Organisation :**

**Evaluation :**

2-hour written exam.

**Target :**

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

<b>Micro-ondes - Bases / Microwave Basics</b>	<b>DET07-MB</b>
<b>Number of hours : 34.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 16.00 h, CM : 10.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**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. Learning of circuit and electromagnetic simulation techniques

**Bibliography :**

- "Microwave Engineering", D.M. Pozar, Wiley

**Requirements :**

DET05-WTLB (Waves and Transmission Lines Basics)  
 DET06-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 E&T students (=1st year of Master degree)

<b>Digital Communications I</b>	<b>DET07-CNUM1</b>
<b>Number of hours : 42.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 22.00 h, TD : 10.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**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 digital modulations.
5. Optimal receiver and performance for unlimited 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. Benedetto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions Communications numériques, M. Hérald, document photocopié.

**Requirements :**

DET05-PRMAT, DET06-COMSYS, DET07-DESTI, DET06-DLS

**Organisation :**

**Evaluation :**

2 two-hour written examinations.  
lecture courses

Mark for practical work and short exams during

**Target :**

4 E&T

<b>VHDL</b>	<b>DET07-VHDL</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 10.00 h, TD : 6.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**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 :**

ESM05-LOG

**Organisation :**

**Evaluation :**

Written examination Mark for practical work

**Target :**

4 E&T



<b>C++ Object Oriented Programming</b>	<b>DET07-INFOC++</b>
<b>Number of hours : 26.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 14.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : ANQUETIL Eric</b>	

**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 :**

**Organisation :**

**Evaluation :**

Mark for laboratory work.

**Target :**

4 E&T

<b>English</b>	<b>HUM07-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : RANNOU Isabelle</b>	

**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  $\zeta$ Toeic Booster $\zeta$  course will be available)

**Bibliography :**

- Oxford Advanced learners $\zeta$  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 :**

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

**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 :**

<b>German: Confirmed Level</b>	<b>HUMF1-ALL</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

To consolidate secondary school level learning outcomes

To attain, as a basic minimum, the B1 level by the end of the first cycle

To practise written and oral comprehension through the use of contemporary supports and multimedia To develop level of oral expression through exercises in small groups and class discussions

To demonstrate and perfect your skills in German through project work

Support for foreign exchange and work placements

**Content :**

- Exercises to practise spoken German for everyday situations and professional life
- Study of newspaper articles, broadcasts, videos
- Study of current affairs (politics, economics, sociology and culture) in Germanophone countries
- Introduction to economic and professional German
- Grammar revision
- Cultural openness (film studies, exhibitions, music)

**Bibliography :**

- DUDEN Bilingual Dictionary (German-French/French-German)
- Grammatik Aktiv A1-B1, Cornelsen (mit Audio CD)\_- Schritte-Ubungsgrammatik A1-B1, Hueber-Verlag
- Übungsgrammatik für die Grundstufe, Hueber-Verlag (Moodle) - Na also!
- Waltraud Legros, Ellipses\_- Manuel : Menschen hier, Hueber-Verlag
- Deutsch perfekt (periodical) -
- Deutsche Welle/ ZDF logo (web) -
- multimedia supports (web)

**Requirements :**

Intermediate German: B1 level

**Organisation :**

1h30 per week; 21h face-to-face lessons per semester

Personal Study time: 14h

Total: 35 h

Students are encouraged to regularly read news articles in German and to view videos and film series in addition to work assigned between lessons.

**Evaluation :**

Basic level : continuous assessment

Intermediate level : continuous assessment

Advanced level : continuous assessment

**Target :**

S1: Final Grade

<b>Spanish</b>	<b>HUMF1-ESP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : AMARGOS GUILLERAY Marine</b>	

**Objectives :**

- Practising and strengthening of one's knowledge in the Spanish language and culture (Spanish culture, Spanish and Latin-American civilizations, societal developments).
- How to manage team projects
- Adapting to multicultural environments
- Understanding social, technological and economical challenges in Spanish-speaking countries.

**Content :**

Written and oral expression and comprehension.

**Bibliography :**

1. PASTOR Enrique and PROST Gisèle : "La grammaire active de l'espagnol", Le livre de poche, collection Les Langues modernes.
2. BECHERELLE, "El arte de conjugar en español", Hatier.
3. Larousse bilingual dictionary, Le Grand Dictionnaire de Garcia y Pelayo et Testas, Dictionary Hispano Bordas.
4. "Passez-moi l'expression en espagnol", Belin.
5. "El español en la prensa", Belin.

**Requirements :**

B1 level

**Organisation :**

- Reinforcing grammar / conjugation
- Reading and oral comprehension
- Writing and speaking (debates, drama).

Advice : Read in Spanish : contemporary novels, comics (Tintin, Astérix, Mafalda), magazines (Cambio 16, Epoca, Vocablo ) available at the library.

Visit the Internet pages of the Spanish and Latin-American newspapers (lavanguardia.es, elpais.es...)

Listen to Spanish National Radio programmes (RNE) on Internet.

Watch TV programmes on RTVE.es.

Read tourist guides on Spanish-speaking countries available at the library.

**Evaluation :**

Continuous assessment

**Target :**

3rd, 4th, 5th year

<b>Chinese</b>	<b>HUMF1-CHI</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

To acquire the basics of Chinese, Essential structures and vocabulary, Comprehension, expression and pronunciation, Use of everyday Chinese.

**Content :**

Oral skills : corrective phonetics (pinyin system), listening to and analysis of complex sentences and simple texts, oral exercises (student-student / student-teacher), introduction of new characters (pronunciation and tone accentuation).  
 Written skills : prose/translation, written production of complex sentences and simple texts, learning and reinforcement of grammatical and vocabulary mechanisms, oral and written Chinese, learning of new characters (order of lines, basic ideograms), reading and analysis of texts, text commentary.

**Bibliography :**

1. Le chinois comme en Chine, Bernard Allanic, Presses Universitaires de Rennes, 2009
  2. Le chinois contemporain, WU Zhongwei, Sinolingua, 2010
  3. Faire l'expérience du chinois, ZHANG Rumei, Ai Xin, Higher Education Press, 2006
- Other documents will be added to these basic books to provide the students with a wide panel of practical exercises.

**Requirements :**

**Organisation :**

Students are required to read the texts from the lessons (in character form), to rewrite the new characters, to work on the application exercises on grammar, lexical and morphological points, to ask questions on the texts from the lessons, to do prose and translation exercises.

**Evaluation :**

Final mark

**Target :**

<b>Japanese</b>	<b>HUMF1-JAP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Niveau débutant (A1):

- awareness of particularities (phonetics, syntax)
- discovery of Japanese culture, traditions, customs
- learning the two systems of writing (Hiragana and Katakana)
- to be able to use spoken Japanese in everyday situations

Intermediate level (A2):

- introduction ideogrammes (60 kanji)
- reading simple texts (with Manga, etc...)
- writing simple texts
- to be able to use spoken Japanese in everyday situations

Advanced level (B1, B2):

- learning kanji (60-200)
- acquiring the four skills (written and oral comprehension, written and oral expression) for travel or study in Japan

**Content :**

Level 1 Beginner (A1):

- Perfecting Hiragana et Katakana - reading Manga
- Lesson 5: speaking about pastimes
- Lesson 6: using transport
- Lesson 7: shopping
- Lesson 8: expressing feelings

Level 2 Beginner (A2):

- learning 30 kanji - reading Manga
- basic Grammar
- reading and writing simple texts
- learning how to communicate in everyday situations

Intermediate level (B1, B2) :

- learning to use more than 30 kanji
- reading Manga
- acquiring the four skills (written and oral comprehension, written and oral expression)

**Bibliography :**

Level 1 Beginner (A1): Margot, 3A Network, to be published, Japan.

Level 2 Beginner (A2): Daichi, 1, 3A Network, 2008, Japan.

Level 3 Intermediate (B1, B2): Minna no Nihongo, I et II, 3A Network, 1998, Japan.

+ Satoru Koyama, J. Bridge, Bonjinsha, 2007, Japan.

**Requirements :**

Level 1: none.

Level 2: to have taken Level A1 Beginner course

Level 3: to have taken Beginner Levels A1 and A2

**Organisation :**

The teaching follows the TU format.

In each session there is an explanation of the structures which are then illustrated by examples and by exercises and conversation which the students participate in.

**Evaluation :**

S1: Final Grade

**Target :**



<b>Russian</b>	<b>HUMF1-RUS</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Russian beginner : acquire A1 level

Russian intermediary : acquire A2/B1 level

**Content :**

Acquisition of grammatical basis and commonplace vocabulary.

Training of the 5 skills, oral and written comprehension, oral and written expression, interaction.

The stress is put on written and oral communication, firstly in the frame of daily situations, then with a progressive introduction of other themes and opening on the professional communication.

Training with varied media (written, audio, video)

Individual exercises and works in groups, talks from the intermediate level on.

Grammar program depending on the level.

(Inter) cultural opening

**Bibliography :**

To be seen with the teacher

**Requirements :**

**Organisation :**

one hour -and-a-half courses per week in SUPELEc

**Evaluation :**

Final grade (overseen by SUPELEC).

**Target :**

**Semestre 7**

**Parcours Formation Initiale E&T**

<b>1</b>	<b>DET07-1</b>		<b>Electronic and Systems</b>	<b>7.50</b>
	DET07-ESNL	O	Non-Linear Electronic Systems	4.00
	DET07-DSP	O	Digital Signal Processing	2.00
	DET07-CDC	C	CDC Project	1.50
	DET07-RECH	C	Research & Innovation Project	1.50
<b>2</b>	<b>DET07-2</b>		<b>Signal Processing</b>	<b>6.50</b>
	DET07-DETC	O	Detection and estimation / Information Theory&Coding	4.50
	DET07-RADIO1	O	Radiocommunications Basics	2.00
<b>3</b>	<b>DET07-3</b>		<b>Communications</b>	<b>6.00</b>
	DET07-MB	O	Micro-ondes - Bases / Microwave Basics	2.50
	DET07-CNUM1	O	Digital Communications I	3.50
<b>4</b>	<b>DET07-4</b>		<b>Design Tools</b>	<b>4.00</b>
	DET07-VHDL	O	VHDL	2.00
	DET07-INFOC++	O	C++ Object Oriented Programming	2.00
<b>5</b>	<b>HUM07</b>		<b>Non-scientific syllabus S7</b>	<b>6.00</b>
	HUM07-ANGL	O	English	2.00
	HUM07-EI	C	Entrepreneurship and Innovation	3.00
	HUM07-IE	C	INNOVATION & ENTREPRENEURSHIP (RIE)	3.00
	HUM07-EPS	O	Sport and physical education	1.00
<b>9</b>	<b>HUMF1-ELSA Mus</b>		<b>Music with studies</b>	<b>1.00</b>
	HUMF1-MUS	F	Music Studies	1.00
<b>11</b>	<b>HUMF1-SAM(DIV)</b>		<b>SAM : APES Responsabilités Associatives</b>	<b>1.00</b>
	HUMF1-APES DIV	F	Association membership & responsibilities 1 credit - Diversity Mission	1.00

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

<b>Non-Linear Electronic Systems</b>	<b>DET07-ESNL</b>
<b>Number of hours : 52.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 4.00 h, CM : 18.00 h, TD : 10.00 h, TP : 16.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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), DET06-SL module.

**Organisation :**

Revision of class notes and practical exercises. Problem solving.

**Evaluation :**

1 two-hour written examination.

Mark for practical work

**Target :**

4 E&T

<b>Digital Signal Processing</b>	<b>DET07-DSP</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 8.00 h, TD : 8.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARTINI AUDREY</b>	

**Objectives :**

Digital signal processing. Use case : STM32F446 and DSPC64x

**Content :**

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

**Bibliography :**

"Traité d'électricité, d'électronique et d'électrotechnique - J.D. CHATELAIN et R. DESSOULAVY - Dunod.  
 Traitement numérique du signal - Gérard Blanchet - Hermes  
 Ingénierie des systèmes à microprocesseurs - Eric Martin et J-I. Philippe - CNET Collections Techniques"

**Requirements :**

DET06-AMI, ESM05-LOG

**Organisation :**

**Evaluation :**

Practice and 1 examination of 1H

**Target :**

4E&T

<b>CDC Project</b>	<b>DET07-CDC</b>
<b>Number of hours : 10.00 h</b>	<b>1.50 ECTS credit</b>
<b>PR : 10.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**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 :**

**Requirements :**

**Organisation :**

**Evaluation :**

Home work

**Target :**

4 E&T

<b>Research &amp; Innovation Project</b>	<b>DET07-RECH</b>
<b>Number of hours : 8.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 8.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

Beginning of the research project proposed to the student: knowledge and skills improvement necessary for its realization (training with the supervisor and/or in autonomy, bibliographic study, first examples, etc.); first simulations and/or characterizations of the studied systems, etc.

**Content :**

Individual work on a research and innovation subject proposed by a researcher from the IETR laboratory. The work is carried out remotely or in the premises of the IETR on sessions dedicated to the DET07-CDC module for other students and on other times of availability.

**Bibliography :**

Function of the proposed research topic. The first elements of the bibliography will be provided by the project supervisor.

**Requirements :**

**Organisation :**

**Evaluation :**

A grade will be awarded by the project supervisor according to the work done and/or a progress report.

**Target :**

4th year E&T students (=1st year of Master degree)  
4 E&T

Detection and estimation / Information Theory&Coding	DET07-DETIK
Number of hours : 58.00 h	4.50 ECTS credit
CM : 20.00 h, CM : 20.00 h, TD : 8.00 h, TD : 4.00 h, TD : 6.00 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. Benedetto, E. Biglieri, V. Castellani, ""Digital transmission theory"", Prentice Hall International Editions."

**Requirements :**

DET05-PROBA, DET05-MATP, DET06-SSPB, SRC06-COMSYS modules

**Organisation :**

Revision of lecture and practical work notes

**Evaluation :**

2 two-hour written examinations.

**Target :**

4 E&T students

<b>Radiocommunications Basics</b>	<b>DET07-RADIO1</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 20.00 h, TD : 8.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

DET05-WTLB (Waves and Transmission Lines Basics)

DET06-EWAB (Electromagnetic Waves and Antennas Basics)

**Organisation :**

**Evaluation :**

2-hour written exam.

**Target :**

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



<b>Micro-ondes - Bases / Microwave Basics</b>	<b>DET07-MB</b>
<b>Number of hours : 34.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 16.00 h, CM : 10.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**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. Learning of circuit and electromagnetic simulation techniques

**Bibliography :**

- "Microwave Engineering", D.M. Pozar, Wiley

**Requirements :**

- DET05-WTLB (Waves and Transmission Lines Basics)
- DET06-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 E&T students (=1st year of Master degree)

<b>Digital Communications I</b>	<b>DET07-CNUM1</b>
<b>Number of hours : 42.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 22.00 h, TD : 10.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**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 digital modulations.
5. Optimal receiver and performance for unlimited 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. Benedetto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions  
 Communications numériques, M. Hérald, document photocopié.

**Requirements :**

DET05-PRMAT, DET06-COMSYS, DET07-DESTI, DET06-DLS

**Organisation :**

**Evaluation :**

2 two-hour written examinations.  
 lecture courses

Mark for practical work and short exams during

**Target :**

4 E&T

<b>VHDL</b>	<b>DET07-VHDL</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 10.00 h, TD : 6.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**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 :**

ESM05-LOG

**Organisation :**

**Evaluation :**

Written examination Mark for practical work

**Target :**

4 E&T

<b>C++ Object Oriented Programming</b>	<b>DET07-INFOC++</b>
<b>Number of hours : 26.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 14.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : ANQUETIL Eric</b>	

**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 :**

**Organisation :**

**Evaluation :**

Mark for laboratory work.

**Target :**

4 E&T

<b>English</b>	<b>HUM07-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : RANNOU Isabelle</b>	

**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  $\zeta$ Toeic Booster $\zeta$  course will be available)

**Bibliography :**

- Oxford Advanced learners $\zeta$  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 :**

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

**Objectives :**

The aim of this module is to assemble a team of students on a business start-up project or product development plan (business plan).

**Content :**

Through conferences, interviews and lectures, students gather the information and advice necessary to set out a business plan. Working in small work groups, the students find, develop and formulate their own business start-up project or product-development plan. Progress is evaluated through progress reports in the form of oral presentations.

Groups also benefit from tutorial sessions.

**Bibliography :**

Provided during the course

**Requirements :**

management simulation module S6

**Organisation :**

4 hours per week

**Evaluation :**

Oral defense and written deliverable

**Target :**

<b>INNOVATION &amp; ENTREPRENEURSHIP (RIE)</b>	<b>HUM07-IE</b>
<b>Number of hours : 54.00 h</b>	<b>3.00 ECTS credit</b>
<b>TD : 54.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

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

**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 :**



<b>Music Studies</b>	<b>HUMF1-MUS</b>
<b>Number of hours : 25.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 25.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- working and communicating in a team
- cultural openness
- listening to others
- managing stress

Students have the opportunity to combine their studies with their passion for music. By joining two Jazz and Classical orchestras, they can continue their instrumental practice and also participate in a quality musical training course supervised by teachers from the Rennes Regional Conservatory. Through group practice, they will be able to develop their skills in listening, collaboration and their ability to adapt, all of which are essential to every kind of teamwork. They will participate actively in the cultural life of the school and frequently perform in public. Collective artistic practice within the institution will promote the personal development of the student.

**Content :**

2h collective lessons per week in the JAZZ et classical music ensembles with instrumental practice training in chamber music. Participation in festivals and organisation of cultural events at INSA. Several concerts and recitals over the year at INA and externally.

**Bibliography :**

Musical scores are distributed at the beginning of the year

**Requirements :**

Good instrumental ability, music studies in conservatory or school of music; ability to read music. Admission to the programme is based on dossier and an audition organised at the beginning of the year.

**Organisation :**

2 hours group practice per week

**Evaluation :**

validation without grade

**Target :**

INSA students, INP, Centrale/Supélec and external students

<b>Association membership &amp; responsibilities 1 credit - Diversity Mission</b>	<b>HUMF1-APES DIV</b>
<b>Number of hours : 60.00 h</b>	<b>1.00 ECTS credit</b>
<b>DIV : 7.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

Semestre 7

Parcours S7 INT - S8 EXT

<b>1</b>	<b>DET07-1</b>		<b>Electronic and Systems</b>	<b>7.50</b>
	DET07-ESNL	O	Non-Linear Electronic Systems	4.00
	DET07-DSP	O	Digital Signal Processing	2.00
	DET07-CDC	C	CDC Project	1.50
	DET07-RECH	C	Research & Innovation Project	1.50
<b>2</b>	<b>DET07-2</b>		<b>Signal Processing</b>	<b>6.50</b>
	DET07-DETC	O	Detection and estimation / Information Theory&Coding	4.50
	DET07-RADIO1	O	Radiocommunications Basics	2.00
<b>3</b>	<b>DET07-3</b>		<b>Communications</b>	<b>6.00</b>
	DET07-MB	O	Micro-ondes - Bases / Microwave Basics	2.50
	DET07-CNUM1	O	Digital Communications I	3.50
<b>4</b>	<b>DET07-4</b>		<b>Design Tools</b>	<b>4.00</b>
	DET07-VHDL	O	VHDL	2.00
	DET07-INFOC++	O	C++ Object Oriented Programming	2.00
<b>5</b>	<b>HUM07</b>		<b>Non-scientific syllabus S7</b>	<b>6.00</b>
	HUM07-ANGL	O	English	2.00
	HUM07-EI	C	Entrepreneurship and Innovation	3.00
	HUM07-IE	C	INNOVATION & ENTREPRENEURSHIP (RIE)	3.00
	HUM07-EPS	O	Sport and physical education	1.00
<b>9</b>	<b>HUMF1-SAM(DIV)</b>		<b>SAM : APES Responsabilités Associatives</b>	<b>1.00</b>
	HUMF1-APES DIV	F	Association membership & responsibilities 1 credit - Diversity Mission	1.00
<b>10</b>	<b>HUMF1-ELSA Mus</b>		<b>Music with studies</b>	<b>1.00</b>
	HUMF1-MUS	F	Music Studies	1.00

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

<b>Non-Linear Electronic Systems</b>	<b>DET07-ESNL</b>
<b>Number of hours : 52.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 4.00 h, CM : 18.00 h, TD : 10.00 h, TP : 16.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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), DET06-SL module.

**Organisation :**

Revision of class notes and practical exercises. Problem solving.

**Evaluation :**

1 two-hour written examination.  
Mark for practical work

**Target :**

4 E&T

<b>Digital Signal Processing</b>	<b>DET07-DSP</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 8.00 h, TD : 8.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : MARTINI AUDREY</b>	

**Objectives :**

Digital signal processing. Use case : STM32F446 and DSPC64x

**Content :**

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

**Bibliography :**

"Traité d'électricité, d'électronique et d'électrotechnique - J.D. CHATELAIN et R. DESSOULAVY - Dunod.  
 Traitement numérique du signal - Gérard Blanchet - Hermes  
 Ingénierie des systèmes à microprocesseurs - Eric Martin et J-I. Philippe - CNET Collections Techniques"

**Requirements :**

DET06-AMI, ESM05-LOG

**Organisation :**

**Evaluation :**

Practice and 1 examination of 1H

**Target :**

4E&T

<b>CDC Project</b>	<b>DET07-CDC</b>
<b>Number of hours : 10.00 h</b>	<b>1.50 ECTS credit</b>
<b>PR : 10.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**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 :**

**Requirements :**

**Organisation :**

**Evaluation :**

Home work

**Target :**

4 E&T

<b>Research &amp; Innovation Project</b>	<b>DET07-RECH</b>
<b>Number of hours : 8.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 8.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

Beginning of the research project proposed to the student: knowledge and skills improvement necessary for its realization (training with the supervisor and/or in autonomy, bibliographic study, first examples, etc.); first simulations and/or characterizations of the studied systems, etc.

**Content :**

Individual work on a research and innovation subject proposed by a researcher from the IETR laboratory. The work is carried out remotely or in the premises of the IETR on sessions dedicated to the DET07-CDC module for other students and on other times of availability.

**Bibliography :**

Function of the proposed research topic. The first elements of the bibliography will be provided by the project supervisor.

**Requirements :**

**Organisation :**

**Evaluation :**

A grade will be awarded by the project supervisor according to the work done and/or a progress report.

**Target :**

4th year E&T students (=1st year of Master degree)  
4 E&T

Detection and estimation / Information Theory&Coding	DET07-DETIC
Number of hours : 58.00 h	4.50 ECTS credit
CM : 20.00 h, CM : 20.00 h, TD : 8.00 h, TD : 4.00 h, TD : 6.00 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 :**

DET05-PROBA, DET05-MATP, DET06-SSPB, SRC06-COMSYS modules

**Organisation :**

Revision of lecture and practical work notes

**Evaluation :**

2 two-hour written examinations.

**Target :**

4 E&T students



<b>Radiocommunications Basics</b>	<b>DET07-RADIO1</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 20.00 h, TD : 8.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

DET05-WTLB (Waves and Transmission Lines Basics)

DET06-EWAB (Electromagnetic Waves and Antennas Basics)

**Organisation :**

**Evaluation :**

2-hour written exam.

**Target :**

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

<b>Micro-ondes - Bases / Microwave Basics</b>	<b>DET07-MB</b>
<b>Number of hours : 34.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 16.00 h, CM : 10.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**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. Learning of circuit and electromagnetic simulation techniques

**Bibliography :**

- "Microwave Engineering", D.M. Pozar, Wiley

**Requirements :**

- DET05-WTLB (Waves and Transmission Lines Basics)
- DET06-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 E&T students (=1st year of Master degree)

<b>Digital Communications I</b>	<b>DET07-CNUM1</b>
<b>Number of hours : 42.00 h</b>	<b>3.50 ECTS credit</b>
<b>CM : 22.00 h, TD : 10.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**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 digital modulations.
5. Optimal receiver and performance for unlimited 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. Benedetto, E. Biglieri, V. Castellani, "Digital transmission theory", Prentice Hall International Editions  
 Communications numériques, M. Hérald, document photocopié.

**Requirements :**

DET05-PRMAT, DET06-COMSYS, DET07-DESTI, DET06-DLS

**Organisation :**

**Evaluation :**

2 two-hour written examinations.  
 lecture courses

Mark for practical work and short exams during

**Target :**

4 E&T

<b>VHDL</b>	<b>DET07-VHDL</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 10.00 h, TD : 6.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**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 :**

ESM05-LOG

**Organisation :**

**Evaluation :**

Written examination Mark for practical work

**Target :**

4 E&T

<b>C++ Object Oriented Programming</b>	<b>DET07-INFOC++</b>
<b>Number of hours : 26.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 14.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : ANQUETIL Eric</b>	

**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 :**

**Organisation :**

**Evaluation :**

Mark for laboratory work.

**Target :**

4 E&T

<b>English</b>	<b>HUM07-ANGL</b>
<b>Number of hours : 28.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 28.00 h</b>	
<b>Reference Teacher(s) : RANNOU Isabelle</b>	

**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  $\zeta$ Toeic Booster $\zeta$  course will be available)

**Bibliography :**

- Oxford Advanced learners $\zeta$  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 :**

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

**Objectives :**

The aim of this module is to assemble a team of students on a business start-up project or product development plan (business plan).

**Content :**

Through conferences, interviews and lectures, students gather the information and advice necessary to set out a business plan. Working in small work groups, the students find, develop and formulate their own business start-up project or product-development plan. Progress is evaluated through progress reports in the form of oral presentations.

Groups also benefit from tutorial sessions.

**Bibliography :**

Provided during the course

**Requirements :**

management simulation module S6

**Organisation :**

4 hours per week

**Evaluation :**

Oral defense and written deliverable

**Target :**

<b>INNOVATION &amp; ENTREPRENEURSHIP (RIE)</b>	<b>HUM07-IE</b>
<b>Number of hours : 54.00 h</b>	<b>3.00 ECTS credit</b>
<b>TD : 54.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**



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

**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 :**

<b>Association membership &amp; responsibilities 1 credit - Diversity Mission</b>	<b>HUMF1-APES DIV</b>
<b>Number of hours : 60.00 h</b>	<b>1.00 ECTS credit</b>
<b>DIV : 7.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Music Studies</b>	<b>HUMF1-MUS</b>
<b>Number of hours : 25.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 25.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- working and communicating in a team
- cultural openness
- listening to others
- managing stress

Students have the opportunity to combine their studies with their passion for music. By joining two Jazz and Classical orchestras, they can continue their instrumental practice and also participate in a quality musical training course supervised by teachers from the Rennes Regional Conservatory. Through group practice, they will be able to develop their skills in listening, collaboration and their ability to adapt, all of which are essential to every kind of teamwork. They will participate actively in the cultural life of the school and frequently perform in public. Collective artistic practice within the institution will promote the personal development of the student.

**Content :**

2h collective lessons per week in the JAZZ et classical music ensembles with instrumental practice training in chamber music. Participation in festivals and organisation of cultural events at INSA. Several concerts and recitals over the year at INA and externally.

**Bibliography :**

Musical scores are distributed at the beginning of the year

**Requirements :**

Good instrumental ability, music studies in conservatory or school of music; ability to read music. Admission to the programme is based on dossier and an audition organised at the beginning of the year.

**Organisation :**

2 hours group practice per week

**Evaluation :**

validation without grade

**Target :**

INSA students, INP, Centrale/Supélec and external students

**Semestre 8**

**Parcours FISP**

<b>0</b>	<b>DET08-ISP</b>		<b>ISP</b>	<b>3.00</b>
	DET08-PROJ-ISP	O	Projet réalisé - Sciences Po	3.00
<b>1</b>	<b>DET08-STAGE</b>		<b>Work placement</b>	<b>8.00</b>
	DET08-STAGE	O	Work Placement	8.00
<b>2</b>	<b>HUM08-ISP</b>		<b>Non-scientific syllabus S8</b>	<b>3.50</b>
	HUM08-ANGL	O	English	2.00
	HUMF2-ALL	C	German	1.50
	HUMF2-ESP	C	Spanish	1.50
	HUMF2-ITA	C	Italian	1.50
	HUMF2-JAP	C	Japanese	1.50
	HUMF2-RUS	C	Russian	1.50

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

<b>Projet réalisé - Sciences Po</b>	<b>DET08-PROJ-ISP</b>
<b>Number of hours : 20.00 h</b>	<b>3.00 ECTS credit</b>
<b>PR : 20.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Work Placement</b>	<b>DET08-STAGE</b>
<b>Number of hours : 240.00 h</b>	<b>8.00 ECTS credit</b>
<b>ST : 1.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

**Evaluation :**

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

**Target :**

4 E&T

<b>English</b>	<b>HUM08-ANGL</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**

<b>German</b>	<b>HUMF2-ALL</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

To consolidate secondary school level learning outcomes

To attain, as a basic minimum, the B1 level by the end of the first cycle

To practise written and oral comprehension through the use of contemporary supports and multimedia

To develop level of oral expression through exercises in small groups and class discussions

To demonstrate and perfect your skills in German through project work

Support for foreign exchange and work placements

**Content :**

Contents:

- Exercises to practise spoken German for everyday situations and professional life
- Study of newspaper articles, broadcasts, videos
- Study of current affairs (politics, economics, sociology and culture) in Germanophone countries
- Introduction to economic and professional German
- Grammar revision
- Cultural openness (film studies, exhibitions, music)

**Bibliography :**

(available in the INSA Rennes library):

- DUDEN Bilingual Dictionary (German-French/French-German)
- Grammatik Aktiv A1-B1, Cornelsen (mit Audio CD)\_ Schritte-Übungsgrammatik A1-B1, Hueber-Verlag
- Übungsgrammatik für die Grundstufe, Hueber-Verlag (Moodle) - Na also!
- Waltraud Legros, Ellipses\_ - Manuel : Menschen hier, Hueber-Verlag
- Deutsch perfekt (periodical) -
- Deutsche Welle/ ZDF logo (web) -
- multimedia supports (web)

**Requirements :**

Intermediate German: B1 level

**Organisation :**

1h30 per week; 21h face-to-face lessons per semester

Personal Study time: 14h

Total: 35 h

Students are encouraged to regularly read news articles in German and to view videos and film series in addition to work assigned between lessons.

**Evaluation :**

S2 : Oral

**Target :**

Engineering students



<b>Spanish</b>	<b>HUMF2-ESP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : AMARGOS GUILLERAY Marine</b>	

**Objectives :**

- Practising and strengthening of one's knowledge in the Spanish language and culture (Spanish culture, Spanish and Latin- American civilizations, societal developments).
- How to manage team projects
- Acquiring, developing know-how and knowledge in a professional and multicultural environment
- Understanding social, technological and economical challenges in Spanish-speaking countries.

**Content :**

**Bibliography :**

1. PASTOR Enrique and PROST Gisèle : "La grammaire active de l'espagnol", Le livre de poche, collection Les Langues modernes.
2. BECHERELLE, "El arte de conjugar en espanol", Hatier.
3. Larousse bilingual dictionary, Le Grand Dictionnaire de Garcia y Pelayo et Testas, Dictionary Hispano Bordas.
4. "Passez-moi l'expression en espagnol", Belin.
5. "El espanol en la prensa", Belin.

**Requirements :**

B1 level

**Organisation :**

- Reinforcing grammar / conjugation
- Reading and oral comprehension
- Writing and speaking (debates, drama).

Advice : Read in Spanish : contemporary novels, comics (Tintin, Astérix, Mafalda), magazines (Cambio 16, Epoca, Vocablo and Don Balon) available at the library.

Visit the Internet pages of the Spanish and Latin-American newspapers (lavanguardia.es, elpais.es...)

Listen to Spanish National Radio programmes (RNE) on Internet.

Watch TV programmes on RTVE.es.

Read tourist guides on Spanish-speaking countries available at the library.

**Evaluation :**

15 mn face to face oral

**Target :**

3rd, 4th, 5th year

<b>Italian</b>	<b>HUMF2-ITA</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : KERSUSAN Sylvia</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Level 1 Beginner :

To introduce the Italian language and Italian culture, to express the fundamentals in writing and orally

Level 2 Advanced Beginner:

By the end of the course, students should be able to converse and write in Italian

Level 3 Intermediate:

To enable students to develop further on themes relating to art, civilisation, literature and cinema

**Content :**

Oral expression and comprehension:

reading with the teacher's guidance on phonetic and grammatical corrections

reading situations in the text, viewing films and reading literary texts and press articles

Written expression and Comprehension:

completing text-based exercises with particular attention to difficulties

summarising situations in available texts and films studied in class

**Bibliography :**

La lingua italiana per Stranieri 1°, 2°, 3°P K.Katerinov

La prova orale 1,2,3 T.Marin

Texts taken from newspapers and Italian magazines, films by famous film directors

**Requirements :**

Level 1 Beginner: none

Level 2 Advanced Beginner : to have attended the Italian Beginner lessons

Level3 Intermediate: to have a good knowledge of the Italian language

**Organisation :**

1h30 of face-face lessons per week; 21h per semester

Personal Study: 14h

To read the photocopied texts provided

**Evaluation :**

S2 : Oral

**Target :**

Engineering students

<b>Japanese</b>	<b>HUMF2-JAP</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- to master a foreign language
- ability to communicate/progress/ work in an international and intercultural context
- cultural openness
- to communicate / interact with others, work in a team
- to work autonomously

Niveau débutant (A1):

- awareness of particularities (phonetics, syntax)
- discovery of Japanese culture, traditions, customs
- learning the two systems of writing (Hiragana and Katakana)
- to be able to use spoken Japanese in everyday situations

Intermediate level (A2):

- introduction ideogrammes (60 kanji)
- reading simple texts (with Manga, etc...)
- writing simple texts
- to be able to use spoken Japanese in everyday situations

Advanced level (B1, B2):

- learning kanji (60-200)
- acquiring the four skills (written and oral comprehension, written and oral expression) for travel or study in Japan

**Content :**

Level 1 Beginner (A1):

- Perfecting Hiragana et Katakana - reading Manga
- Lesson 5: speaking about pastimes
- Lesson 6: using transport
- Lesson 7: shopping
- Lesson 8: expressing feelings

Level 2 Beginner (A2):

- learning 30 kanji - reading Manga
- basic Grammar
- reading and writing simple texts
- learning how to communicate in everyday situations

Intermediate level (B1, B2) :

- learning to use more than 30 kanji
- reading Manga
- acquiring the four skills (written and oral comprehension, written and oral expression)

**Bibliography :**

Level 1 Beginner (A1): Margot, 3A Network, to be published, Japan.

Level 2 Beginner (A2): Daichi, 1, 3A Network, 2008, Japan.

Level 3 Intermediate (B1, B2): Minna no Nihongo, I et II, 3A Network, 1998, Japan.

+ Satoru Koyama, J. Bridge, Bonjinsha, 2007, Japan.

**Requirements :**

Level 1: none.

Level 2: to have taken Level A1 Beginner course

Level 3: to have taken Beginner Levels A1 and A2

**Organisation :**

The teaching follows the TU format.

In each session there is an explanation of the structures which are then illustrated by examples and by exercises and conversation which the students participate in.

**Evaluation :**

S2 : Oral

**Target :**

Engineering students

<b>Russian</b>	<b>HUMF2-RUS</b>
<b>Number of hours : 21.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 21.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

According to level: Beginners (A1), Intermediate (A2/B1), Advanced (B1-B2). Help the students to progress autonomously.

**Content :**

Written and oral communication. Firstly in everyday life situations, and secondly in other fields such as professional topics.

- Films and book extracts are used as a learning aid
- Individual exercises and group work, oral presentations for intermediates
- Grammar
- Cinema, literature and civilization.

**Bibliography :**

**Requirements :**

**Organisation :**

Classes take place at SUPELEC (Campus de Beaulieu)

**Evaluation :**

Final grade (overseen by SUPELEC).

**Target :**

**Semestre 8**

**Parcours Formation Initiale E&T**

<b>1</b>	<b>DET08-1</b>		<b>Microwaves circuits and antennas</b>	<b>5.00</b>
	DET08-MW	O	Microwaves	2.00
	DET08-WA	O	Waveguides and Antennas	2.00
	DET08-RADIO-2	O	Radiocommunications-2	1.00
<b>2</b>	<b>DET08-2</b>		<b>Radar Systems and project</b>	<b>6.00</b>
	DET08-SYRAD	O	Radar Systems	1.50
	DET08-TSRS	O	Radar and Sonar Signal Processing	2.00
	DET08-PROJ	C	Electronic Students projects	2.50
	DET08-RECH	C	Research & Innovation Project	2.50
<b>3</b>	<b>DET08-3</b>		<b>Communication Networks</b>	<b>5.00</b>
	DET08-RES	O	Data Networks	1.00
	DET08-CNUM2	O	Digital Communications 2	2.50
	DET08-MNUM	O	Methods for digital computing	1.50
<b>4</b>	<b>HUM08</b>		<b>Non-scientific syllabus S8</b>	<b>6.00</b>
	HUM08-ANGL	O	English	2.00
	HUM08-TEJS	C	ECONOMIC, LEGAL AND SOCIAL ISSUES	1.00
	HUM08-SHES1	O	Engineer & Society - M1	1.00
	HUM08-SHES2	C	Engineer & Society - M2	1.00
	HUM08-EPS	O	Sport and Physical Education	1.00
	HUM08-IE	C	INNOVATION & ENTREPRENEURSHIP (RIE)	2.00
<b>5</b>	<b>DET08-STAGE</b>		<b>Work placement</b>	<b>8.00</b>
	DET08-STAGE	O	Work Placement	8.00

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

<b>Microwaves</b>	<b>DET08-MW</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 18.00 h, CM : 6.00 h, PR : 10.00 h</b>	
<b>Reference Teacher(s) : GILLARD Raphael</b>	

**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, Wiley  
 - ""Electromagnetic Waves and Antennas"", S.J. Orfanidis, <http://www.ece.rutgers.edu/~orfanidi/ewa/>"

**Requirements :**

"DET05-WTLB (Waves and Transmission Lines Basics)  
 DET06-EWAB (Electromagnetic Waves and Antennas Basics)  
 DET07-MB (Microwaves Basics)"

**Organisation :**

**Evaluation :**

2-hour written exam - Possible short random exams during lectures to capitalize bonus marks. Marks for project.

**Target :**

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

<b>Waveguides and Antennas</b>	<b>DET08-WA</b>
<b>Number of hours : 36.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 16.00 h, CM : 10.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : GARCIA VIGUERAS Maria</b>	

**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, Wiley
- ""Antenna Theory, analysis and design"", C.A. Balanis, Wiley
- ""Electromagnetic Waves and Antennas"", S.J. Orfanidis, <http://www.ece.rutgers.edu/~orfanidi/ewa/>"

**Requirements :**

"DET05-WTLB (Waves and Transmission Lines Basics)  
 DET06-EWAB (Electromagnetic Waves and Antennas Basics)  
 DET07-MB (Microwaves Basics)"

**Organisation :**

**Evaluation :**

2 hour exam including questions on practical works.

**Target :**

1st year of master's degree



<b>Radiocommunications-2</b>	<b>DET08-RADIO-2</b>
<b>Number of hours : 13.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 2.00 h, TD : 2.00 h, TP : 4.50 h, TP : 4.50 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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. des antennes, bilans de liaison, interférences.

**Bibliography :**

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

**Requirements :**

**Organisation :**

**Evaluation :**

2 two-hour written examinations.

**Target :**

4 E&T

<b>Radar Systems</b>	<b>DET08-SYRAD</b>
<b>Number of hours : 26.50 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 16.00 h, TD : 6.00 h, TP : 4.50 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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 :**

**Evaluation :**

Two-hour written examination.

**Target :**

4 E&T

<b>Radar and Sonar Signal Processing</b>	<b>DET08-TSRS</b>
<b>Number of hours : 26.50 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 16.00 h, TD : 6.00 h, TP : 4.50 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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."

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 :**

Modulus DET06-EWAB, DET06-SSPB, DET07-ESNL, DET07-SYRAD

**Organisation :**

**Evaluation :**

Two-hour written examination.

**Target :**

4 E&T

<b>Electronic Students projects</b>	<b>DET08-PROJ</b>
<b>Number of hours : 20.00 h</b>	<b>2.50 ECTS credit</b>
<b>PR : 20.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**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

"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 :**

**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 :**

4 E&T

<b>Research &amp; Innovation Project</b>	<b>DET08-RECH</b>
<b>Number of hours : 20.00 h</b>	<b>2.50 ECTS credit</b>
<b>PR : 20.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

This second period of the research project will allow the student to analyze, simulate, test or characterize the solutions adopted at the end of the first studies carried out within the framework of the DET07-RECH module. A rise in skills in both theoretical, software and hardware tools is expected.

**Content :**

Continuation of individualized work on a research and innovation subject started as part of the DET07-RECH module. The work is mainly carried out in the premises of the IETR on sessions dedicated to the DET08-PROJ module for other students and on other times of availability.

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

A grade will be awarded by the project supervisor according to the work done and/or a progress report.

**Target :**

4E&T

<b>Data Networks</b>	<b>DET08-RES</b>
<b>Number of hours : 36.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 6.00 h, CM : 6.00 h, TP : 6.00 h</b>	
<b>Reference Teacher(s) : FARAH Joumana</b>	

**Objectives :**

Routing protocols and TCP level 4. VLAN.

**Content :**

1- routing protocols;

2- TCP and congestion;exercices during the lessons

3- Mechanisms in IP network : VLAN, VPN , spanning Tree.

Lab : 6H, builds a complete network, using wired and wireless equipments, routers, and servers

**Bibliography :**

Fun platform and OpenClassroom - Cisco labs

**Requirements :**

DET06-RES1

**Organisation :**

**Evaluation :**

1H 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)

<b>Digital Communications 2</b>	<b>DET08-CNUM2</b>
<b>Number of hours : 38.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 20.00 h, TD : 6.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

"This second session of digital communications follows the first session DET07-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  $\hat{\imath}$  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. Benedetto, 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. Benedetto, 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 :**

DET05-SPB, DET06-SSPB, DET06-COMSYS, DET07-CNUM1, DET07-DETIC

**Organisation :**

**Evaluation :**

2 two-hour written examinations including questions about lab exercises

**Target :**

4 E&T



<b>Methods for digital computing</b>	<b>DET08-MNUM</b>
<b>Number of hours : 26.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 12.00 h, TD : 14.00 h</b>	
<b>Reference Teacher(s) : ZAHARIA Gheorghe</b>	

**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 :**

4 E&T

<b>English</b>	<b>HUM08-ANGL</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**

<b>ECONOMIC, LEGAL AND SOCIAL ISSUES</b>	<b>HUM08-TEJS</b>
<b>Number of hours : 10.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 10.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**Objectives :**

This course focuses on economic, legal and social matters. Students are encouraged to develop their curiosity and their ability to analyse topics related to the general environment of a company.

Main learning outcomes:

- Understanding key concepts related to a firm's environment
- Establishing a specific-vocabulary base
- Develop their curiosity and critical thinking

**Content :**

The topics covered may vary depending on the speakers and the the current events, however attention will be paid to two subjects in particular: the financial and monetary system (MSM), climate change (STIC).

**Bibliography :**

Provided during the course

**Requirements :**

None

**Organisation :**

**Evaluation :**

Continuous assessment (collective work)

**Target :**

<b>Engineer &amp; Society - M1</b>	<b>HUM08-SHES1</b>
<b>Number of hours : 14.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 14.00 h</b>	
<b>Reference Teacher(s) : ECHARD Philippe</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Engineer &amp; Society - M2</b>	<b>HUM08-SHES2</b>
<b>Number of hours : 14.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 14.00 h</b>	
<b>Reference Teacher(s) : ECHARD Philippe</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

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

**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 :**

<b>INNOVATION &amp; ENTREPRENEURSHIP (RIE)</b>	<b>HUM08-IE</b>
<b>Number of hours : 48.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 48.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**



<b>Work Placement</b>	<b>DET08-STAGE</b>
<b>Number of hours : 240.00 h</b>	<b>8.00 ECTS credit</b>
<b>ST : 1.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

**Evaluation :**

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

**Target :**

4 E&T

**Semestre 8**

**Parcours S7 EXT - S8 INT**

<b>1</b>	<b>DET08-1</b>		<b>Microwaves circuits and antennas</b>	<b>5.00</b>
	DET08-MW	O	Microwaves	2.00
	DET08-WA	O	Waveguides and Antennas	2.00
	DET08-RADIO-2	O	Radiocommunications-2	1.00
<b>2</b>	<b>DET08-2</b>		<b>Radar Systems and project</b>	<b>6.00</b>
	DET08-SYRAD	O	Radar Systems	1.50
	DET08-TSRS	O	Radar and Sonar Signal Processing	2.00
	DET08-PROJ	C	Electronic Students projects	2.50
	DET08-RECH	C	Research & Innovation Project	2.50
<b>3</b>	<b>DET08-3</b>		<b>Communication Networks</b>	<b>5.00</b>
	DET08-RES	O	Data Networks	1.00
	DET08-CNUM2	O	Digital Communications 2	2.50
	DET08-MNUM	O	Methods for digital computing	1.50
<b>4</b>	<b>HUM08</b>		<b>Non-scientific syllabus S8</b>	<b>6.00</b>
	HUM08-ANGL	O	English	2.00
	HUM08-TEJS	C	ECONOMIC, LEGAL AND SOCIAL ISSUES	1.00
	HUM08-SHES1	O	Engineer & Society - M1	1.00
	HUM08-SHES2	C	Engineer & Society - M2	1.00
	HUM08-EPS	O	Sport and Physical Education	1.00
	HUM08-IE	C	INNOVATION & ENTREPRENEURSHIP (RIE)	2.00
<b>5</b>	<b>DET08-STAGE</b>		<b>Work placement</b>	<b>8.00</b>
	DET08-STAGE	O	Work Placement	8.00

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

<b>Microwaves</b>	<b>DET08-MW</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 18.00 h, CM : 6.00 h, PR : 10.00 h</b>	
<b>Reference Teacher(s) : GILLARD Raphael</b>	

**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, Wiley

- ""Electromagnetic Waves and Antennas"", S.J. Orfanidis, <http://www.ece.rutgers.edu/~orfanidi/ewa/>

**Requirements :**

"DET05-WTLB (Waves and Transmission Lines Basics)

DET06-EWAB (Electromagnetic Waves and Antennas Basics)

DET07-MB (Microwaves Basics)"

**Organisation :**

**Evaluation :**

2-hour written exam - Possible short random exams during lectures to capitalize bonus marks. Marks for project.

**Target :**

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

<b>Waveguides and Antennas</b>	<b>DET08-WA</b>
<b>Number of hours : 36.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 16.00 h, CM : 10.00 h, TP : 10.00 h</b>	
<b>Reference Teacher(s) : GARCIA VIGUERAS Maria</b>	

**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, Wiley
- ""Antenna Theory, analysis and design"", C.A. Balanis, Wiley
- ""Electromagnetic Waves and Antennas"", S.J. Orfanidis, <http://www.ece.rutgers.edu/~orfanidi/ewa/>"

**Requirements :**

"DET05-WTLB (Waves and Transmission Lines Basics)  
 DET06-EWAB (Electromagnetic Waves and Antennas Basics)  
 DET07-MB (Microwaves Basics)"

**Organisation :**

**Evaluation :**

2 hour exam including questions on practical works.

**Target :**

1st year of master's degree

<b>Radiocommunications-2</b>	<b>DET08-RADIO-2</b>
<b>Number of hours : 13.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 2.00 h, TD : 2.00 h, TP : 4.50 h, TP : 4.50 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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. des antennes, bilans de liaison, interférences.

**Bibliography :**

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

**Requirements :**

**Organisation :**

**Evaluation :**

2 two-hour written examinations.

**Target :**

4 E&T

<b>Radar Systems</b>	<b>DET08-SYRAD</b>
<b>Number of hours : 26.50 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 16.00 h, TD : 6.00 h, TP : 4.50 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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 :**

**Evaluation :**

Two-hour written examination.

**Target :**

4 E&T

<b>Radar and Sonar Signal Processing</b>	<b>DET08-TSRS</b>
<b>Number of hours : 26.50 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 16.00 h, TD : 6.00 h, TP : 4.50 h</b>	
<b>Reference Teacher(s) : MERIC Stephane</b>	

**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."

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 :**

Modulus DET06-EWAB, DET06-SSPB, DET07-ESNL, DET07-SYRAD

**Organisation :**

**Evaluation :**

Two-hour written examination.

**Target :**

4 E&T

<b>Electronic Students projects</b>	<b>DET08-PROJ</b>
<b>Number of hours : 20.00 h</b>	<b>2.50 ECTS credit</b>
<b>PR : 20.00 h</b>	
<b>Reference Teacher(s) : LEMOINE Christophe</b>	

**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

"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 :**

**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 :**

4 E&T



<b>Research &amp; Innovation Project</b>	<b>DET08-RECH</b>
<b>Number of hours : 20.00 h</b>	<b>2.50 ECTS credit</b>
<b>PR : 20.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

This second period of the research project will allow the student to analyze, simulate, test or characterize the solutions adopted at the end of the first studies carried out within the framework of the DET07-RECH module. A rise in skills in both theoretical, software and hardware tools is expected.

**Content :**

Continuation of individualized work on a research and innovation subject started as part of the DET07-RECH module. The work is mainly carried out in the premises of the IETR on sessions dedicated to the DET08-PROJ module for other students and on other times of availability.

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

A grade will be awarded by the project supervisor according to the work done and/or a progress report.

**Target :**

4E&T

<b>Data Networks</b>	<b>DET08-RES</b>
<b>Number of hours : 36.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 6.00 h, CM : 6.00 h, TP : 6.00 h</b>	
<b>Reference Teacher(s) : FARAH Joumana</b>	

**Objectives :**

Routing protocols and TCP level 4. VLAN.

**Content :**

1- routing protocols;

2- TCP and congestion;exercices during the lessons

3- Mechanisms in IP network : VLAN, VPN , spanning Tree.

Lab : 6H, builds a complete network, using wired and wireless equipments, routers, and servers

**Bibliography :**

Fun platform and OpenClassroom - Cisco labs

**Requirements :**

DET06-RES1

**Organisation :**

**Evaluation :**

1H 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)

<b>Digital Communications 2</b>	<b>DET08-CNUM2</b>
<b>Number of hours : 38.00 h</b>	<b>2.50 ECTS credit</b>
<b>CM : 20.00 h, TD : 6.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

"This second session of digital communications follows the first session DET07-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  $\hat{\imath}$  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. Benedetto, 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. Benedetto, 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 :**

DET05-SPB, DET06-SSPB, DET06-COMSYS, DET07-CNUM1, DET07-DETIC

**Organisation :**

**Evaluation :**

2 two-hour written examinations including questions about lab exercises

**Target :**

4 E&T

<b>Methods for digital computing</b>	<b>DET08-MNUM</b>
<b>Number of hours : 26.00 h</b>	<b>1.50 ECTS credit</b>
<b>CM : 12.00 h, TD : 14.00 h</b>	
<b>Reference Teacher(s) : ZAHARIA Gheorghe</b>	

**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 :**

4 E&T

<b>English</b>	<b>HUM08-ANGL</b>
<b>Number of hours : 24.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 24.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**

<b>ECONOMIC, LEGAL AND SOCIAL ISSUES</b>	<b>HUM08-TEJS</b>
<b>Number of hours : 10.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 10.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**Objectives :**

This course focuses on economic, legal and social matters. Students are encouraged to develop their curiosity and their ability to analyse topics related to the general environment of a company.

Main learning outcomes:

- Understanding key concepts related to a firm's environment
- Establishing a specific-vocabulary base
- Develop their curiosity and critical thinking

**Content :**

The topics covered may vary depending on the speakers and the the current events, however attention will be paid to two subjects in particular: the financial and monetary system (MSM), climate change (STIC).

**Bibliography :**

Provided during the course

**Requirements :**

None

**Organisation :****Evaluation :**

Continuous assessment (collective work)

**Target :**



<b>Engineer &amp; Society - M1</b>	<b>HUM08-SHES1</b>
<b>Number of hours : 14.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 14.00 h</b>	
<b>Reference Teacher(s) : ECHARD Philippe</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Engineer &amp; Society - M2</b>	<b>HUM08-SHES2</b>
<b>Number of hours : 14.00 h</b>	<b>1.00 ECTS credit</b>
<b>CM : 14.00 h</b>	
<b>Reference Teacher(s) : ECHARD Philippe</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

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

**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 :**

<b>INNOVATION &amp; ENTREPRENEURSHIP (RIE)</b>	<b>HUM08-IE</b>
<b>Number of hours : 48.00 h</b>	<b>2.00 ECTS credit</b>
<b>TD : 48.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Work Placement</b>	<b>DET08-STAGE</b>
<b>Number of hours : 240.00 h</b>	<b>8.00 ECTS credit</b>
<b>ST : 1.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

**Evaluation :**

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

**Target :**

4 E&T

Semestre 8

Parcours S7 INT - S8 EXT

1	DET08-STAGE		Work placement	8.00
	DET08-STAGE	O	Work Placement	8.00

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

<b>Work Placement</b>	<b>DET08-STAGE</b>
<b>Number of hours : 240.00 h</b>	<b>8.00 ECTS credit</b>
<b>ST : 1.00 h</b>	
<b>Reference Teacher(s) : EL ZEIN Ghais</b>	

**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 :**

**Evaluation :**

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

**Target :**

4 E&T

Semestre 9

Contrat de Professionnalisation

<b>1</b>	<b>DET09-D-CPRO</b>		<b>Disciplinaires CPRO</b>	<b>12.00</b>
	DET09-D-CISY	C	Systems and Circuits	4.00
	DET09-D-DIRA	C	Radiofrequency and Antenna Devices	4.00
	DET09-D-SYCA	C	Advanced Communication Systems	4.00
	DET09-D-TASE-ANA	C	Processing and Architecture of Analog Electronic Systems	4.00
	DET09-D-TASE-NUM	C	Processing and Architecture of Digital Electronic Systems	4.00
<b>2</b>	<b>DET09-MP-CPRO</b>		<b>Métiers et Projet parcours contrat Pro</b>	<b>12.00</b>
	DET09-M-SNET	C	Smart Networks	4.00
	DET09-M-SPES	C	Space Electronic Systems	4.00
	DET09-M-SYNS	C	System and Network Security	4.00
<b>3</b>	<b>HUM09-DET-PRO</b>		<b>HUMANITES CONTRAT PRO E&amp;T</b>	<b>6.00</b>
	HUM09-PM-PRO	O	Economics, Law and Business Studies (Professional management)	2.00
	HUM10-ANG-PRO-DET	O	S9- Anglais parcours Pro (S10)	2.00
	DET10-SPEC PRO	O	Expérience en entreprise	2.00

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



<b>Systems and Circuits</b>	<b>DET09-D-CISY</b>
<b>Number of hours : 40.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 28.00 h, TD : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

In this course, students will become familiar with machine learning techniques with a particular focus on their application in the telecommunications domain. In particular, students will be able to recognize a problem where supervised or unsupervised reinforcement learning can be applied. Students will be able to define an agent, a set of states and actions and a reward function to apply a reinforcement learning algorithm. They will be able to design a neural network, determine a suitable cost function and train it. They will be able to implement in Python the methods seen in class. In particular, they will know the PyTorch machine learning library and how to use its main features.

**Content :**

This course consists of two parts: one part on supervised and unsupervised learning approaches and one part on reinforcement learning. The first part will introduce machine learning in a general way, as well as classify the main problems concerned in three large categories (supervised, unsupervised and reinforcement learning). Then, the simplest techniques in supervised and unsupervised learning will be presented (classification, regression, clustering, dimension reduction). Finally, this first part will be concluded by an introduction to neural networks (architecture, optimization, examples). In the second part, the notion of Markovian decision process is introduced as well as that of a decision agent, with sets of states and actions and a reward function. From the definition of the state-value and action-state-value functions, the Bellman equation is proved. The Q-learning and SARSA algorithms are introduced. Finally we conclude with the Bandit algorithms as a special case of reinforcement learning algorithm.

"

**Bibliography :**

"Deep Learning", Ian Goodfellow, Yoshua Bengio and Aaron Courville

**Requirements :**

Courses DET05-SPB, DET06-SSPB, DET07-DETIC

**Organisation :**

**Evaluation :**

One exam of 2 hours and one project in small group.

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Radiofrequency and Antenna Devices</b>	<b>DET09-D-DIRA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h, TP : 4.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Give a complementary training about RF devices and antennas. Highlight the link between circuits properties and overall performance at system level. Study array antennas (theory, design, synthesis) and associated technologies. Give an overview of the use of periodic structures to control EM radiation. Introduce high-frequency methods for the study of large radiating apertures and scattering.

**Content :**

This module is made of two courses. The first one (RF devices) studies the impact of RF circuits defaults on the overall performance of a communication system. The lecture is followed by a lab showing the effect of high-power amplifier nonlinearities on the quality of a digital transmission. The second course is dedicated to antenna arrays and periodic structures. It also includes material about scattering and associated simulation approaches. A simulation lab illustrates practical aspects of antenna array design.

This module is made of two courses. The first one (RF devices) studies the impact of RF circuits defaults on the overall performance of a communication system. The lecture is followed by a lab showing the effect of high-power amplifier nonlinearities on the quality of a digital transmission. The second course is dedicated to antenna arrays and periodic structures. It also includes material about scattering and associated simulation approaches. A simulation lab illustrates practical aspects of antenna array design.

**Bibliography :**

Microwave Engineering, POZAR, Wiley - "Antenna Theory", BALANIS, Wiley.

**Requirements :**

Microwave circuits; Digital Communications; Electromagnetism and Antennas. Specific knowledge about Keysight ADS and Matlab software tools.

**Organisation :**

**Evaluation :**

Two 1h-examens (Antennas and Periodic Structures; RF devices and Scattering) + Lab tests

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Advanced Communication Systems</b>	<b>DET09-D-SYCA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 30.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

The SYCA course aims to provide its audience with an introduction to state-of-the-art techniques in the areas of channel coding, multi-antenna communication techniques and spread spectrum systems. At the end of this course, students will be able to: recognize the structure of a Turbo code, describe the main steps of an iterative MAP decoding, characterize the structure of an LDPC code and implement a bit-flipping decoding algorithm. In spectrum spreading, we study the different techniques used, as well as the different codes implemented for spreading. Finally, we will illustrate these techniques through application examples. For multi-antenna communications, students will be able to: categorize the different multi-antenna techniques (time-space coding, channel formation, spatial multiplexing, SDMA) and know the different types of associated receivers (linear, non-linear, interference cancellation, etc). It will also be necessary to understand the specificities of channel models adapted to multi-antenna systems and to know how to analyze the capacity of these channels (channel rank, propagation eigenmodes). The course will seek to show the use of multi-antenna techniques in current standards (LTE, Wifi, etc.).

**Content :**

The course is divided into three parts: advanced channel coding, MIMO systems, spread spectrum systems. The advanced channel coding part contains the following elements: reminder on convolutional codes, Turbo codes (structure and decoding), LDPC codes (structure and decoding). For the spread spectrum course, it includes five parts: principle, techniques, coding, synchronization, applications. For the course on MIMO systems, the topics covered are: principles and definitions, MIMO capacity, time-space coding, beamforming, multi-user MIMO systems.

**Bibliography :**

**Requirements :**

Courses DET05-SPB, DET06-SSPB, DET07-DETC, DET07-CNUM1, DET07-RADIO1, DET08-CNUM2, DET08-RADIO2

**Organisation :**

**Evaluation :**

A exam of 4 hours and one project in small group

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Processing and Architecture of Analog Electronic Systems</b>	<b>DET09-D-TASE-ANA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 10.00 h, CONF : 4.00 h, PR : 22.00 h, TD : 6.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

Deepen knowledge and skills on microwave circuits and subsystems, dedicated technologies and associated simulation tools.

**Content :**

This module is divided into 2 parts. A first one (lectures, tutorials) will present advanced topologies, architectures and technologies used in integrated front-ends: passive and active circuits, printed antennas, Systems in Package (SiP), reconfiguration technologies, "smart antennas", reconfigurable active arrays, 3D additive manufacturing and the main associated EM simulation techniques. The second one (practical lab) will be dedicated to the design of advanced circuits and antennas using commercial simulation softwares.

**Bibliography :**

"Microwave Engineering", POZAR,Wiley - "Antenna Theory", BALANIS, Wiley.

**Requirements :**

Microwave circuits; Electromagnetism and Antennas. Specific knowledge about Keysight ADS.

**Organisation :**

**Evaluation :**

One 2h-examens + project evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Processing and Architecture of Digital Electronic Systems</b>	<b>DET09-D-TASE-NUM</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 14.00 h, PR : 16.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**Objectives :**

Deepen knowledge and skills on digital systems, associated technologies and real-time management of these systems

**Content :**

"This module is composed of 3 parts. The first part presents SoPC (System On Programmable Chip) architectures by reviewing current technologies as well as associated design methodologies. A second part deals with the real-time management of these circuits by focusing on the concept of embedded OS and the management of peripherals. The third part of the module consists of a 16-hour project implementing all the concepts acquired in class. The project concerns the design of a digital system implementing embedded processors and the management of various sensors (temperature, humidity, brightness, accelerometer, etc.)

"

**Bibliography :**

**Requirements :**

Digital logic, Programmable Logic, C Language

**Organisation :**

**Evaluation :**

Exam + project evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Smart Networks</b>	<b>DET09-M-SNET</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 20.00 h, CONF : 6.00 h, TP : 16.00 h</b>	<b>handout in English</b>
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**Objectives :**

The module aims to give engineering students a culture on the subject of wireless systems and networks through a description of the main techniques used and their applications, with an emphasis on their physical layer.

**Content :**

The module is structured as follows:

- Introduction to the fundamental bases of wireless networks (mobile radio, local networks, core networks, etc.)
- Cellular networks and the associated transmission techniques from 1G to 5G (8H)
- Conference on emerging xG cellular technologies (2H)
- Network deployment in urban areas (Course + 8h practical work)
- WLAN/WPAN/WBAN local networks (4H)
- Fiber technologies for core networks (4H)
- Core and IP networks (course + 8H practical work)
- IoT communicating object systems (Course + 8H practical work)

**Bibliography :**

**Requirements :**

Signal processing and Telecommunications training

**Organisation :**

**Evaluation :**

2 hour exam at the end of the module (Multiple Choice Questions exam type) + practical lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Space Electronic Systems</b>	<b>DET09-M-SPES</b>
<b>Number of hours : 41.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 33.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LOISON Renaud</b>	

**Objectives :**

The module aims to give a basic culture to engineering students on the wide subject of space electronic systems.

**Content :**

"The module is organized as follows:

- Introduction to space systems (6h)
- Earth observation systems (8h)
- Satellite communications (2h)
- Architectures of radiofrequency systems (2h)
- Antennas: BFN and multibeam antennas (3h)
- Antennas: future technologies (4h)
- Radio astronomy and numerical aspects (4h)
- Fault tolerance of spatial digital systems (4h)
- Measurement and analysis of GNSS signals with USRP maps (8h practical work)"

**Bibliography :**

**Requirements :**

Electronics and Telecommunications training (low and high frequency analog electronics, digital electronics, signal processing for telecommunications)

**Organisation :**

**Evaluation :**

2 short exams (Multiple Choice Questions exam type) + practical lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>System and Network Security</b>	<b>DET09-M-SYNS</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 4.00 h, CM : 12.00 h, CM : 6.00 h, CM : 2.00 h, TP : 6.00 h, TP : 12.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**Objectives :**

The objective of this module is to present the issues and basic principles of the security of communicating systems.

**Content :**

The module is composed of three parts. The first part provides basic knowledge in computer and network security while illustrating the course with real use cases. The second part of the module gives the fundamentals in software security by focusing on embedded aspects. Finally, a third part of the module focuses on the hardware security of connected objects by presenting current attacks and planned countermeasures. Practical work will be carried out to implement the acquired concepts on embedded hardware platforms.

**Bibliography :**

The Hardware Hacking Handbook, Jasper van Woudenberg and Colin O'Flynn, no starch press

**Requirements :**

Basic Networks architecture, hardware architectures

**Organisation :**

**Evaluation :**

MCQ -like exam + Lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training



<b>Economics, Law and Business Studies (Professional management)</b>	<b>HUM09-PM-PRO</b>
<b>Number of hours : 70.00 h</b>	<b>2.00 ECTS credit</b>
<b>TA : 70.00 h, TA : 70.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>S9- Anglais parcours Pro (S10)</b>	<b>HUM10-ANG-PRO-DET</b>
<b>Number of hours : 20.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 20.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Expérience en entreprise</b>	<b>DET10-SPEC PRO</b>
<b>Number of hours : 30.00 h</b>	<b>2.00 ECTS credit</b>
<b>PR : 0.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

**Semestre 9**

**Parcours Formation Initiale E&T**

<b>1</b>	<b>DET09-D</b>		<b>Disciplinaires</b>	<b>8.00</b>
	DET09-D-CISY	C	Systems and Circuits	4.00
	DET09-D-DIRA	C	Radiofrequency and Antenna Devices	4.00
	DET09-D-SYCA	C	Advanced Communication Systems	4.00
	DET09-D-TASE-ANA	C	Processing and Architecture of Analog Electronic Systems	4.00
	DET09-D-TASE-NUM	C	Processing and Architecture of Digital Electronic Systems	4.00
<b>2</b>	<b>DET09-MP</b>		<b>Métiers et Projet</b>	<b>16.00</b>
	DET09-M-SNET	C	Smart Networks	4.00
	DET09-M-SPES	C	Space Electronic Systems	4.00
	DET09-M-SYNS	C	System and Network Security	4.00
	DET09-PROJ	C	Industrial Project	8.00
	DET09-IMARS-CRI	C	Research and Innovation Culture	5.00
<b>3</b>	<b>HUMF1-SAM(DIV)</b>		<b>SAM : APES Responsabilités Associatives</b>	<b>1.00</b>
	HUMF1-APES DIV	F	Association membership & responsibilities 1 credit - Diversity Mission	1.00
<b>4</b>	<b>HUM09-DET</b>		<b>HUMANITES E&amp;T</b>	<b>6.00</b>
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-PM-A	C	Economics, Law and Business Studies A - LEAN MANAGEMENT	2.00
	HUM09-PM-B	C	Economics, Law and Business Studies B (Human Resources 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 AND ETHICS FOR ENGINEERS	2.00
	HUM09-PM-E	C	Economics, Law and Business Studies E (INTERNATIONAL DEVELOPPEMENT & STRATEGIES)	2.00
	HUM09-PM-F	C	Economics, Law and Business Studies F (sustainable development)	2.00
<b>5</b>	<b>HUMF1-ELSA Mus</b>		<b>Music with studies</b>	<b>1.00</b>
	HUMF1-MUS	F	Music Studies	1.00

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

<b>Systems and Circuits</b>	<b>DET09-D-CISY</b>
<b>Number of hours : 40.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 28.00 h, TD : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

In this course, students will become familiar with machine learning techniques with a particular focus on their application in the telecommunications domain. In particular, students will be able to recognize a problem where supervised or unsupervised reinforcement learning can be applied. Students will be able to define an agent, a set of states and actions and a reward function to apply a reinforcement learning algorithm. They will be able to design a neural network, determine a suitable cost function and train it. They will be able to implement in Python the methods seen in class. In particular, they will know the PyTorch machine learning library and how to use its main features.

**Content :**

This course consists of two parts: one part on supervised and unsupervised learning approaches and one part on reinforcement learning. The first part will introduce machine learning in a general way, as well as classify the main problems concerned in three large categories (supervised, unsupervised and reinforcement learning). Then, the simplest techniques in supervised and unsupervised learning will be presented (classification, regression, clustering, dimension reduction). Finally, this first part will be concluded by an introduction to neural networks (architecture, optimization, examples). In the second part, the notion of Markovian decision process is introduced as well as that of a decision agent, with sets of states and actions and a reward function. From the definition of the state-value and action-state-value functions, the Bellman equation is proved. The Q-learning and SARSA algorithms are introduced. Finally we conclude with the Bandit algorithms as a special case of reinforcement learning algorithm.

"

**Bibliography :**

"Deep Learning", Ian Goodfellow, Yoshua Bengio and Aaron Courville

**Requirements :**

Courses DET05-SPB, DET06-SSPB, DET07-DETIC

**Organisation :**

**Evaluation :**

One exam of 2 hours and one project in small group.

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Radiofrequency and Antenna Devices</b>	<b>DET09-D-DIRA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h, TP : 4.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Give a complementary training about RF devices and antennas. Highlight the link between circuits properties and overall performance at system level. Study array antennas (theory, design, synthesis) and associated technologies. Give an overview of the use of periodic structures to control EM radiation. Introduce high-frequency methods for the study of large radiating apertures and scattering.

**Content :**

This module is made of two courses. The first one (RF devices) studies the impact of RF circuits defaults on the overall performance of a communication system. The lecture is followed by a lab showing the effect of high-power amplifier nonlinearities on the quality of a digital transmission. The second course is dedicated to antenna arrays and periodic structures. It also includes material about scattering and associated simulation approaches. A simulation lab illustrates practical aspects of antenna array design.

This module is made of two courses. The first one (RF devices) studies the impact of RF circuits defaults on the overall performance of a communication system. The lecture is followed by a lab showing the effect of high-power amplifier nonlinearities on the quality of a digital transmission. The second course is dedicated to antenna arrays and periodic structures. It also includes material about scattering and associated simulation approaches. A simulation lab illustrates practical aspects of antenna array design.

**Bibliography :**

Microwave Engineering, POZAR, Wiley - "Antenna Theory", BALANIS, Wiley.

**Requirements :**

Microwave circuits; Digital Communications; Electromagnetism and Antennas. Specific knowledge about Keysight ADS and Matlab software tools.

**Organisation :**

**Evaluation :**

Two 1h-examens (Antennas and Periodic Structures; RF devices and Scattering) + Lab tests

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Advanced Communication Systems</b>	<b>DET09-D-SYCA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 30.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

The SYCA course aims to provide its audience with an introduction to state-of-the-art techniques in the areas of channel coding, multi-antenna communication techniques and spread spectrum systems. At the end of this course, students will be able to: recognize the structure of a Turbo code, describe the main steps of an iterative MAP decoding, characterize the structure of an LDPC code and implement a bit-flipping decoding algorithm. In spectrum spreading, we study the different techniques used, as well as the different codes implemented for spreading. Finally, we will illustrate these techniques through application examples. For multi-antenna communications, students will be able to: categorize the different multi-antenna techniques (time-space coding, channel formation, spatial multiplexing, SDMA) and know the different types of associated receivers (linear, non-linear, interference cancellation, etc). It will also be necessary to understand the specificities of channel models adapted to multi-antenna systems and to know how to analyze the capacity of these channels (channel rank, propagation eigenmodes). The course will seek to show the use of multi-antenna techniques in current standards (LTE, Wifi, etc.).

**Content :**

The course is divided into three parts: advanced channel coding, MIMO systems, spread spectrum systems. The advanced channel coding part contains the following elements: reminder on convolutional codes, Turbo codes (structure and decoding), LDPC codes (structure and decoding). For the spread spectrum course, it includes five parts: principle, techniques, coding, synchronization, applications. For the course on MIMO systems, the topics covered are: principles and definitions, MIMO capacity, time-space coding, beamforming, multi-user MIMO systems.

**Bibliography :**

**Requirements :**

Courses DET05-SPB, DET06-SSPB, DET07-DETC, DET07-CNUM1, DET07-RADIO1, DET08-CNUM2, DET08-RADIO2

**Organisation :**

**Evaluation :**

A exam of 4 hours and one project in small group

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Processing and Architecture of Analog Electronic Systems</b>	<b>DET09-D-TASE-ANA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 10.00 h, CONF : 4.00 h, PR : 22.00 h, TD : 6.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

Deepen knowledge and skills on microwave circuits and subsystems, dedicated technologies and associated simulation tools.

**Content :**

This module is divided into 2 parts. A first one (lectures, tutorials) will present advanced topologies, architectures and technologies used in integrated front-ends: passive and active circuits, printed antennas, Systems in Package (SiP), reconfiguration technologies, "smart antennas", reconfigurable active arrays, 3D additive manufacturing and the main associated EM simulation techniques. The second one (practical lab) will be dedicated to the design of advanced circuits and antennas using commercial simulation softwares.

**Bibliography :**

"Microwave Engineering", POZAR,Wiley - "Antenna Theory", BALANIS, Wiley.

**Requirements :**

Microwave circuits; Electromagnetism and Antennas. Specific knowledge about Keysight ADS.

**Organisation :**

**Evaluation :**

One 2h-examens + project evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training



<b>Processing and Architecture of Digital Electronic Systems</b>	<b>DET09-D-TASE-NUM</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 14.00 h, PR : 16.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**Objectives :**

Deepen knowledge and skills on digital systems, associated technologies and real-time management of these systems

**Content :**

"This module is composed of 3 parts. The first part presents SoPC (System On Programmable Chip) architectures by reviewing current technologies as well as associated design methodologies. A second part deals with the real-time management of these circuits by focusing on the concept of embedded OS and the management of peripherals. The third part of the module consists of a 16-hour project implementing all the concepts acquired in class. The project concerns the design of a digital system implementing embedded processors and the management of various sensors (temperature, humidity, brightness, accelerometer, etc.)

"

**Bibliography :**

**Requirements :**

Digital logic, Programmable Logic, C Language

**Organisation :**

**Evaluation :**

Exam + project evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Smart Networks</b>	<b>DET09-M-SNET</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 20.00 h, CONF : 6.00 h, TP : 16.00 h</b>	<b>handout in English</b>
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**Objectives :**

The module aims to give engineering students a culture on the subject of wireless systems and networks through a description of the main techniques used and their applications, with an emphasis on their physical layer.

**Content :**

The module is structured as follows:

- Introduction to the fundamental bases of wireless networks (mobile radio, local networks, core networks, etc.)
- Cellular networks and the associated transmission techniques from 1G to 5G (8H)
- Conference on emerging xG cellular technologies (2H)
- Network deployment in urban areas (Course + 8h practical work)
- WLAN/WPAN/WBAN local networks (4H)
- Fiber technologies for core networks (4H)
- Core and IP networks (course + 8H practical work)
- IoT communicating object systems (Course + 8H practical work)

**Bibliography :**

**Requirements :**

Signal processing and Telecommunications training

**Organisation :**

**Evaluation :**

2 hour exam at the end of the module (Multiple Choice Questions exam type) + practical lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Space Electronic Systems</b>	<b>DET09-M-SPES</b>
<b>Number of hours : 41.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 33.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LOISON Renaud</b>	

**Objectives :**

The module aims to give a basic culture to engineering students on the wide subject of space electronic systems.

**Content :**

"The module is organized as follows:

- Introduction to space systems (6h)
- Earth observation systems (8h)
- Satellite communications (2h)
- Architectures of radiofrequency systems (2h)
- Antennas: BFN and multibeam antennas (3h)
- Antennas: future technologies (4h)
- Radio astronomy and numerical aspects (4h)
- Fault tolerance of spatial digital systems (4h)
- Measurement and analysis of GNSS signals with USRP maps (8h practical work)"

**Bibliography :**

**Requirements :**

Electronics and Telecommunications training (low and high frequency analog electronics, digital electronics, signal processing for telecommunications)

**Organisation :**

**Evaluation :**

2 short exams (Multiple Choice Questions exam type) + practical lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>System and Network Security</b>	<b>DET09-M-SYNS</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 4.00 h, CM : 12.00 h, CM : 6.00 h, CM : 2.00 h, TP : 6.00 h, TP : 12.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**Objectives :**

The objective of this module is to present the issues and basic principles of the security of communicating systems.

**Content :**

The module is composed of three parts. The first part provides basic knowledge in computer and network security while illustrating the course with real use cases. The second part of the module gives the fundamentals in software security by focusing on embedded aspects. Finally, a third part of the module focuses on the hardware security of connected objects by presenting current attacks and planned countermeasures. Practical work will be carried out to implement the acquired concepts on embedded hardware platforms.

**Bibliography :**

The Hardware Hacking Handbook, Jasper van Woudenberg and Colin O'Flynn, no starch press

**Requirements :**

Basic Networks architecture, hardware architectures

**Organisation :**

**Evaluation :**

MCQ -like exam + Lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Industrial Project</b>	<b>DET09-PROJ</b>
<b>Number of hours : 40.00 h</b>	<b>8.00 ECTS credit</b>
<b>EP : 40.00 h</b>	
<b>Reference Teacher(s) : DARDAILLON Mickael</b>	

**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."

**Bibliography :**

Previous years reports.

**Requirements :**

**Organisation :**

**Evaluation :**

One marks corresponding to the evaluation of the work that has been performed

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Research and Innovation Culture</b>	<b>DET09-IMARS-CRI</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 12.00 h, TD : 9.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Get familiar with research environment and practises. Discover regulatory and legal aspects, research work methodology. Participate in a project focused on the production of new scientific knowledge.

**Content :**

This module is made of three parts. The first one (CVM) addresses the general issue of IP and innovation (patent, publication, start-up creation). It is given by external experts on innovation and value addition. The second one (MR) consists of a bibliographic work, done in small groups, under the supervision of a teacher providing the subject. A fictive journal paper has to be produced and an oral presentation given during an internal mini-conference. The third part (PRJ) is a scientific project, in small groups, aiming at providing a theoretical study supported by relevant simulations/modelizations.

**Bibliography :**

Material produced by students in previous years (available in Moodle).

**Requirements :**

English language. Scientific skills from other modules.

**Organisation :**

**Evaluation :**

1 written exam for CVM (1h). Evaluation of produced material (written paper and oral talk) for MR. Evaluation of produced material for PRJ.

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Association membership &amp; responsibilities 1 credit - Diversity Mission</b>	<b>HUMF1-APES DIV</b>
<b>Number of hours : 60.00 h</b>	<b>1.00 ECTS credit</b>
<b>DIV : 7.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>TOEIC 5th year</b>	<b>HUM09-ANGL-TOEIC</b>
<b>Number of hours : 20.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 20.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**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



<b>English S9 Conversation</b>	<b>HUM09-ANGL-CONV</b>
<b>Number of hours : 10.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 10.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**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 :**

<b>Economics, Law and Business Studies A - LEAN MANAGEMENT</b>	<b>HUM09-PM-A</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

The Management Course should enable students:  
 to engage with «management-oriented» themes d'aborder des thèmes « orientés métiers » relative to management,  
 to personalise their programme by choosing modules «à la carte», in accordance with their interests and professional projects.

Each student chooses one course from the list of suggested courses.

Beyond the specific skills that are the focus of each course, the learning outcomes can be identified as follows:

- to understand and know how to use the specialised vocabulary of management
- to recognise the main issues in a chosen management theme
- to practise teamwork: taking decisions collectively and be able to deliver within set deadlines

**Lean Management (28h)**

- To master the theoretical concepts and practices of Lean and Six Sigma
- To develop your capacity to manage and lead value-creating projects
- To understand the issues of associated with a culture of continuous progress and, by extension, its implementation within an organisation

**Legal Knowledge (6h)**

**Objectives**

- To acquire a general knowledge of the law
- To understand the organisation and main principles of the legal environment

**Content :**

«Lean Management» Course Programme  
 Lean Management (28h)

Lean Management is a structured management method. It is increasingly becoming an approach to improve the performance of companies through improved process efficiency.

Applied to company management, « Lean Management » offers a range of methods to work towards operational excellence.

Associated with the «Six Sigma» methodology which is designed to improve quality, Lean offers an approach that ensures that all customer expectations in terms of quality, deadlines and costs are taken into account.

**Programme**

The content of this course develops and deepens understanding of certain notions seen in the core curriculum for 3rd Year (IMO).

Introduction to improvement

DMAIC Project

Organising and Leading a team

specific Lean tools

specific Six Sigma tools

field-oriented Lean and Six Sigma tools

feedback from industry and industrial applications

Students registered in this module will be able to participate in the Hackathon of quality and operational excellence organized in December in Nantes. This event will bring together for a whole day teams made up of 4 to 6 students from several educational institutions from Bac + 2 to Master 2 level, supervised by professionals in operational excellence, QHSE management, continuous improvement ...

Together, the students will have to take up the challenge of responding to a real business problem and proposing a relevant action plan. At the end of the day, each team will pitch their final work. The best presentation will be rewarded with a vote from the public and the jury of experts.

Legal Knowledge (6h)

sources of law, the hierarchy of rules, notion of jurisprudence;  
jurisdictions;  
types of law practitioners;  
the contract;  
civil and criminal liability in a company

**Bibliography :**

A specific bibliography on the themes developed is suggested to students in class

**Requirements :**

Eco-Management Modules in S7 and S8

**Organisation :**

The different Management courses bring together students from the various speciality Departments. Each course includes the participation of external speakers (industry professionals, lawyers or consultants). Interactive pedagogy and project work are favoured, with students working in teams on projects that are defined in collaboration with the speakers.

**Evaluation :**

Continuous Assessment: teamwork with oral and/or written assignment

**Target :**

<b>Economics, Law and Business Studies B (Human Resources Management)</b>	<b>HUM09-PM-B</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) : BOUGUENNEC Christelle</b>	

**Objectives :**

Objectives of Management Courses

The Management Course should enable students:

to engage with «management-oriented» themes relative to management,  
to personalise their programme by choosing modules «à la carte», in accordance with their interests and professional projects.

Each student chooses a course from a list of suggested options:

Beyond the specific skills that are the focus of each course, the learning outcomes can be identified as follows:

1. to understand and know how to use the specialised vocabulary of management
2. to recognise the main issues in a chosen management theme
3. to practise teamwork: taking decisions collectively and be able to deliver within set deadlines

Human Resources Management (20h)

This module therefore specifically aims to:

make future engineers aware of individual and collective management  
identify the expectations associated with the manager's mission  
equip students with the tools and techniques suited to the manager's mission

Labour Law (8h)

To make future engineers aware of the right to work by giving them key aspects of comprehension in this area which has been rendered more complex due to the diversity of its origins, the multiplication of reforms and frequent changes in jurisprudence.

To enable future engineers therefore to access the labour market with a concise overview of their rights and obligations within a company

Legal Knowledge (6h)

- To acquire a general knowledge of the law
- To understand the organisation and main principles of the legal environment

**Content :**

«Human Resources Management» Course Programme

Human Resources Management (20h)

Confronted with numerous and ever rapid changes, it is imperative for companies to adapt in order to ensure their sustainability and development. In this context, human management is capital. Leaders must know how to lead, develop and organise the skills of their teams that are necessary to meet objectives and at the same time create commitment in ways that nurture energies sustainably

Programme

the essentials of management  
communication and motivation  
knowing how to set objectives  
leadership and team leadership  
developing teamwork skills  
managing complexity  
supporting change

Labour Law (8h)

background to Labour law

the work contract : study of some essential clauses (workplace, salaries, work hours, non-competitive clause  
some elements on the different types of work contract termination

Legal Knowledge (6h)

- sources of law, the hierarchy of rules, notion of jurisprudence;

- jurisdictions;
- types of law practitioners;
- the contract;
- civil and criminal liability in a company

**Bibliography :**

A specific bibliography on the themes developed is suggested to students in class.

**Requirements :**

Eco-Management Modules in S7 and S8

**Organisation :**

The different Management courses bring together students from the various speciality Departments. Each course includes the participation of external speakers (industry professionals, lawyers or consultants). Interactive pedagogy and project work are favoured, with students working in teams on projects that are defined in collaboration with the speakers

**Evaluation :**

Continuous Assessment: teamwork with oral and/or written assignment

**Target :**

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

**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 :**

<b>Economics, Law and Business Studies D MANAGEMENT AND ETHICS FOR ENGINEERS</b>	<b>HUM09-PM-D</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**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 :**

- The fundamentals of management
  - Ethics and business practices (international and corporate frameworks and regulations, impact on project management and decision processes)
  - Reflexion on personal motivations related to social and environmental impact of innovation and business, personal values vs professional goals)
- Transversal approach by industry sector case studies

**Bibliography :**

Given during the course

**Requirements :**

NONE

**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 :**

<b>Economics, Law and Business Studies E (INTERNATIONAL DEVELOPPEMENT &amp; STRATEGIES)</b>	<b>HUM09-PM-E</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**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

**Bibliography :**

Given during the course

**Requirements :**

None

**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 :**



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

**Objectives :**

Sustainable Development (28h)

Sustainable development is a major societal issue that challenges all stakeholders, including training and research institutions. The INSA group has taken up this theme and actively engages with the ways and means of "training engineers to a very high technical level... [but who are also] aware of today's global challenges & capable of helping their companies to make their own energy and ecological transition "(Inter-INSA Energy-Climate Challenges Working Group in engineer training).

INSA Rennes has committed to the SDSR (Sustainable Development and Social Responsibility) accreditation process. The Engineering students enrolled in Course F will be able to contribute concretely to this process by presenting projects that meet the requirements of this standard, in collaboration with the COPIL-DD (Sustainable Development Piloting Committee) and the CRIC-DD (Rennes Inter-Campus Collective for Sustainable Development).

**Objectives**

- To deepen your knowledge of SDS issues and be able to raise awareness of them;
- To understand the SD standards and the stages of the accreditation process;
- To build a team project that serves the accreditation of INSA Rennes ;
- To know how to convince others of your project's relevance and to assess its feasibility (technical and economic)

**Legal Knowledge (6h)**

**Objectives**

- To acquire a general knowledge of the law
- To understand the organisation and main principles of the legal environment

**Content :**

**Programme**

Presentation of COPIL-DD (Sustainable Development Piloting Committee), CRIC-DD (Rennes Inter-Campus Collective for Sustainable Development) and SD-SR accreditation  
 Conferences on SD: environmental impacts of digital technology , biodiversity and gardens, SSS (Social et Solidarity Space), etc.  
 Training on the «Fresco for the Climate» tool

**Legal Knowledge (6h)**

**Programme**

sources of law, the hierarchy of rules, notion of jurisprudence;  
 jurisdictions;  
 types of law practioners;  
 the contract;  
 civil and criminal liability in a company

**Bibliography :**

A specific bibliography on the themes developed is suggested to students in class

**Requirements :**

Eco-Management Modules in S7 and S8

**Organisation :**

The different Management courses bring together students from the various speciality Departments. Each course includes the participation of external speakers (industry professionals, lawyers or consultants). Interactive pedagogy and project work are favoured, with students working in teams on projects that are defined in collaboration with the speakers

As part of this module, the student engineers:

- will attend conferences on SD themes
- will be trained on how to use the «Fresco for the Climate» tool

- will work in pluridisciplinary teams to develop a project that is eligible for SD-SR accreditation and can be implemented on campus.

Personal study time will be provided for within the schedule in order to allow students to advance with the team projects

**Evaluation :**

Continuous assessment (collective work)

**Target :**

<b>Music Studies</b>	<b>HUMF1-MUS</b>
<b>Number of hours : 25.00 h</b>	<b>1.00 ECTS credit</b>
<b>TD : 25.00 h</b>	
<b>Reference Teacher(s) : HOLZNER-JACQUES Cecile</b>	

**Objectives :**

Targeted skills :

- working and communicating in a team
- cultural openness
- listening to others
- managing stress

Students have the opportunity to combine their studies with their passion for music. By joining two Jazz and Classical orchestras, they can continue their instrumental practice and also participate in a quality musical training course supervised by teachers from the Rennes Regional Conservatory. Through group practice, they will be able to develop their skills in listening, collaboration and their ability to adapt, all of which are essential to every kind of teamwork. They will participate actively in the cultural life of the school and frequently perform in public. Collective artistic practice within the institution will promote the personal development of the student.

**Content :**

2h collective lessons per week in the JAZZ et classical music ensembles with instrumental practice training in chamber music. Participation in festivals and organisation of cultural events at INSA. Several concerts and recitals over the year at INA and externally.

**Bibliography :**

Musical scores are distributed at the beginning of the year

**Requirements :**

Good instrumental ability, music studies in conservatory or school of music; ability to read music. Admission to the programme is based on dossier and an audition organised at the beginning of the year.

**Organisation :**

2 hours group practice per week

**Evaluation :**

validation without grade

**Target :**

INSA students, INP, Centrale/Supélec and external students

Semestre 9

Parcours 5ET+Master

1	DET09-D-MASTER		Disciplinaires DD MASTER	16.00
	DET09-D-CISY	C	Systems and Circuits	4.00
	DET09-D-DIRA	C	Radiofrequency and Antenna Devices	4.00
	DET09-D-SYCA	C	Advanced Communication Systems	4.00
	DET09-D-TASE-ANA	C	Processing and Architecture of Analog Electronic Systems	4.00
	DET09-D-TASE-NUM	C	Processing and Architecture of Digital Electronic Systems	4.00
	DET09-IMARS-D-CISY	C		5.00
	DET09-IMARS-D-DIRA	C	Radiofrequency and Antenna Devices, additional research work	5.00
	DET09-IMARS-D-SYCA	C	Advanced Communication Systems, additionnal research work	5.00
	DET09-IMARS-TASE-ANA	ANAC	Processing and Architecture of Analog Electronic Systems, additionnal research work	5.00
	DET09-IMARS-TASE-NUM	NUMC	Processing and Architecture of Digital Electronic Systems, additionnal research work	5.00
	DET09-IMARS-CRI	O	Research and Inovation Culture	5.00
2	DET09-MP-MASTER		Métiers et Projet parcours DD MASTER	9.00
	DET09-M-SNET	C	Smart Networks	4.00
	DET09-M-SPES	C	Space Electronic Systems	4.00
	DET09-M-SYNS	C	System and Network Security	4.00
	DET09-IMARS-CRI	C	Research and Inovation Culture	5.00
3	HUM09-DET		HUMANITES E&T	6.00
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-PM-A	C	Economics, Law and Business Studies A - LEAN MANAGEMENT	2.00
	HUM09-PM-B	C	Economics, Law and Business Studies B (Human Resources 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 AND ETHICS FOR ENGINEERS	2.00
	HUM09-PM-E	C	Economics, Law and Business Studies E (INTERNATIONAL DEVELOPPEMENT & STRATEGIES)	2.00
	HUM09-PM-F	C	Economics, Law and Business Studies F (sustainable development)	2.00

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

<b>Systems and Circuits</b>	<b>DET09-D-CISY</b>
<b>Number of hours : 40.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 28.00 h, TD : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

In this course, students will become familiar with machine learning techniques with a particular focus on their application in the telecommunications domain. In particular, students will be able to recognize a problem where supervised or unsupervised reinforcement learning can be applied. Students will be able to define an agent, a set of states and actions and a reward function to apply a reinforcement learning algorithm. They will be able to design a neural network, determine a suitable cost function and train it. They will be able to implement in Python the methods seen in class. In particular, they will know the PyTorch machine learning library and how to use its main features.

**Content :**

This course consists of two parts: one part on supervised and unsupervised learning approaches and one part on reinforcement learning. The first part will introduce machine learning in a general way, as well as classify the main problems concerned in three large categories (supervised, unsupervised and reinforcement learning). Then, the simplest techniques in supervised and unsupervised learning will be presented (classification, regression, clustering, dimension reduction). Finally, this first part will be concluded by an introduction to neural networks (architecture, optimization, examples). In the second part, the notion of Markovian decision process is introduced as well as that of a decision agent, with sets of states and actions and a reward function. From the definition of the state-value and action-state-value functions, the Bellman equation is proved. The Q-learning and SARSA algorithms are introduced. Finally we conclude with the Bandit algorithms as a special case of reinforcement learning algorithm.

"

**Bibliography :**

"Deep Learning", Ian Goodfellow, Yoshua Bengio and Aaron Courville

**Requirements :**

Courses DET05-SPB, DET06-SSPB, DET07-DETIC

**Organisation :**

**Evaluation :**

One exam of 2 hours and one project in small group.

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Radiofrequency and Antenna Devices</b>	<b>DET09-D-DIRA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h, TP : 4.00 h, TP : 4.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Give a complementary training about RF devices and antennas. Highlight the link between circuits properties and overall performance at system level. Study array antennas (theory, design, synthesis) and associated technologies. Give an overview of the use of periodic structures to control EM radiation. Introduce high-frequency methods for the study of large radiating apertures and scattering.

**Content :**

This module is made of two courses. The first one (RF devices) studies the impact of RF circuits defaults on the overall performance of a communication system. The lecture is followed by a lab showing the effect of high-power amplifier nonlinearities on the quality of a digital transmission. The second course is dedicated to antenna arrays and periodic structures. It also includes material about scattering and associated simulation approaches. A simulation lab illustrates practical aspects of antenna array design.

This module is made of two courses. The first one (RF devices) studies the impact of RF circuits defaults on the overall performance of a communication system. The lecture is followed by a lab showing the effect of high-power amplifier nonlinearities on the quality of a digital transmission. The second course is dedicated to antenna arrays and periodic structures. It also includes material about scattering and associated simulation approaches. A simulation lab illustrates practical aspects of antenna array design.

**Bibliography :**

Microwave Engineering, POZAR, Wiley - "Antenna Theory", BALANIS, Wiley.

**Requirements :**

Microwave circuits; Digital Communications; Electromagnetism and Antennas. Specific knowledge about Keysight ADS and Matlab software tools.

**Organisation :**

**Evaluation :**

Two 1h-examens (Antennas and Periodic Structures; RF devices and Scattering) + Lab tests

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Advanced Communication Systems</b>	<b>DET09-D-SYCA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 30.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : MARY Philippe</b>	

**Objectives :**

The SYCA course aims to provide its audience with an introduction to state-of-the-art techniques in the areas of channel coding, multi-antenna communication techniques and spread spectrum systems. At the end of this course, students will be able to: recognize the structure of a Turbo code, describe the main steps of an iterative MAP decoding, characterize the structure of an LDPC code and implement a bit-flipping decoding algorithm. In spectrum spreading, we study the different techniques used, as well as the different codes implemented for spreading. Finally, we will illustrate these techniques through application examples. For multi-antenna communications, students will be able to: categorize the different multi-antenna techniques (time-space coding, channel formation, spatial multiplexing, SDMA) and know the different types of associated receivers (linear, non-linear, interference cancellation, etc). It will also be necessary to understand the specificities of channel models adapted to multi-antenna systems and to know how to analyze the capacity of these channels (channel rank, propagation eigenmodes). The course will seek to show the use of multi-antenna techniques in current standards (LTE, Wifi, etc.).

**Content :**

The course is divided into three parts: advanced channel coding, MIMO systems, spread spectrum systems. The advanced channel coding part contains the following elements: reminder on convolutional codes, Turbo codes (structure and decoding), LDPC codes (structure and decoding). For the spread spectrum course, it includes five parts: principle, techniques, coding, synchronization, applications. For the course on MIMO systems, the topics covered are: principles and definitions, MIMO capacity, time-space coding, beamforming, multi-user MIMO systems.

**Bibliography :**

**Requirements :**

Courses DET05-SPB, DET06-SSPB, DET07-DETC, DET07-CNUM1, DET07-RADIO1, DET08-CNUM2, DET08-RADIO2

**Organisation :**

**Evaluation :**

A exam of 4 hours and one project in small group

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Processing and Architecture of Analog Electronic Systems</b>	<b>DET09-D-TASE-ANA</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 10.00 h, CONF : 4.00 h, PR : 22.00 h, TD : 6.00 h</b>	
<b>Reference Teacher(s) : FOURN Erwan</b>	

**Objectives :**

Deepen knowledge and skills on microwave circuits and subsystems, dedicated technologies and associated simulation tools.

**Content :**

This module is divided into 2 parts. A first one (lectures, tutorials) will present advanced topologies, architectures and technologies used in integrated front-ends: passive and active circuits, printed antennas, Systems in Package (SiP), reconfiguration technologies, "smart antennas", reconfigurable active arrays, 3D additive manufacturing and the main associated EM simulation techniques. The second one (practical lab) will be dedicated to the design of advanced circuits and antennas using commercial simulation softwares.

**Bibliography :**

"Microwave Engineering", POZAR, Wiley - "Antenna Theory", BALANIS, Wiley.

**Requirements :**

Microwave circuits; Electromagnetism and Antennas. Specific knowledge about Keysight ADS.

**Organisation :**

**Evaluation :**

One 2h-examens + project evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training



<b>Processing and Architecture of Digital Electronic Systems</b>	<b>DET09-D-TASE-NUM</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 14.00 h, PR : 16.00 h, TP : 12.00 h</b>	
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**Objectives :**

Deepen knowledge and skills on digital systems, associated technologies and real-time management of these systems

**Content :**

"This module is composed of 3 parts. The first part presents SoPC (System On Programmable Chip) architectures by reviewing current technologies as well as associated design methodologies. A second part deals with the real-time management of these circuits by focusing on the concept of embedded OS and the management of peripherals. The third part of the module consists of a 16-hour project implementing all the concepts acquired in class. The project concerns the design of a digital system implementing embedded processors and the management of various sensors (temperature, humidity, brightness, accelerometer, etc.)

"

**Bibliography :**

**Requirements :**

Digital logic, Programmable Logic, C Language

**Organisation :**

**Evaluation :**

Exam + project evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

	<b>DET09-IMARS-D-CISY</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 28.00 h, TD : 6.00 h, TP : 12.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) :</b>	

**Objectives :**

Additional reseach-oriented work as part of the IMARS master's degree

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Radiofrequency and Antenna Devices, additional research work</b>	<b>DET09-IMARS-D-DIRA</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 10.00 h, TP : 8.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) :</b>	

**Objectives :**

Additional research-oriented work as part of the IMARS master's degree.

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Advanced Communication Systems, additionnal research work</b>	<b>DET09-IMARS-D-SYCA</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 6.00 h, TP : 12.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) :</b>	

**Objectives :**

Additional research-oriented work as part of the IMARS master-s degree.

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Processing and Architecture of Analog Electronic Systems, additional research work</b>	<b>DET09-IMARS-TASE-ANA</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 14.00 h, TD : 12.00 h, TP : 22.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) :</b>	

**Objectives :**

Additional reseach-oriented work as part of the IMARS master's degree

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

Processing and Architecture of Digital Electronic Systems, additional research work	DET09-IMARS-TASE-NUM
Number of hours : 100.00 h	5.00 ECTS credit
CM : 14.00 h, TD : 6.00 h, TP : 28.00 h	hand-out in English and course taught in English
Reference Teacher(s) :	

**Objectives :**

Additional research-oriented work as part of the IMARS master's degree.

**Content :**

**Bibliography :**

**Requirements :**

**Organisation :**

**Evaluation :**

**Target :**

<b>Research and Innovation Culture</b>	<b>DET09-IMARS-CRI</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 12.00 h, TD : 9.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Get familiar with research environment and practises. Discover regulatory and legal aspects, research work methodology. Participate in a project focused on the production of new scientific knowledge.

**Content :**

This module is made of three parts. The first one (CVM) addresses the general issue of IP and innovation (patent, publication, start-up creation). It is given by external experts on innovation and value addition. The second one (MR) consists of a bibliographic work, done in small groups, under the supervision of a teacher providing the subject. A fictive journal paper has to be produced and an oral presentation given during an internal mini-conference. The third part (PRJ) is a scientific project, in small groups, aiming at providing a theoretical study supported by relevant simulations/modelizations.

**Bibliography :**

Material produced by students in previous years (available in Moodle).

**Requirements :**

English language. Scientific skills from other modules.

**Organisation :**

**Evaluation :**

1 written exam for CVM (1h). Evaluation of produced material (written paper and oral talk) for MR. Evaluation of produced material for PRJ.

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Smart Networks</b>	<b>DET09-M-SNET</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 20.00 h, CONF : 6.00 h, TP : 16.00 h</b>	<b>handout in English</b>
<b>Reference Teacher(s) : CRUSSIÈRE Matthieu</b>	

**Objectives :**

The module aims to give engineering students a culture on the subject of wireless systems and networks through a description of the main techniques used and their applications, with an emphasis on their physical layer.

**Content :**

The module is structured as follows:

- Introduction to the fundamental bases of wireless networks (mobile radio, local networks, core networks, etc.)
- Cellular networks and the associated transmission techniques from 1G to 5G (8H)
- Conference on emerging xG cellular technologies (2H)
- Network deployment in urban areas (Course + 8h practical work)
- WLAN/WPAN/WBAN local networks (4H)
- Fiber technologies for core networks (4H)
- Core and IP networks (course + 8H practical work)
- IoT communicating object systems (Course + 8H practical work)

**Bibliography :**

**Requirements :**

Signal processing and Telecommunications training

**Organisation :**

**Evaluation :**

2 hour exam at the end of the module (Multiple Choice Questions exam type) + practical lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training



<b>Space Electronic Systems</b>	<b>DET09-M-SPES</b>
<b>Number of hours : 41.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 33.00 h, TP : 8.00 h</b>	
<b>Reference Teacher(s) : LOISON Renaud</b>	

**Objectives :**

The module aims to give a basic culture to engineering students on the wide subject of space electronic systems.

**Content :**

"The module is organized as follows:

- Introduction to space systems (6h)
- Earth observation systems (8h)
- Satellite communications (2h)
- Architectures of radiofrequency systems (2h)
- Antennas: BFN and multibeam antennas (3h)
- Antennas: future technologies (4h)
- Radio astronomy and numerical aspects (4h)
- Fault tolerance of spatial digital systems (4h)
- Measurement and analysis of GNSS signals with USRP maps (8h practical work)"

**Bibliography :**

**Requirements :**

Electronics and Telecommunications training (low and high frequency analog electronics, digital electronics, signal processing for telecommunications)

**Organisation :**

**Evaluation :**

2 short exams (Multiple Choice Questions exam type) + practical lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>System and Network Security</b>	<b>DET09-M-SYNS</b>
<b>Number of hours : 42.00 h</b>	<b>4.00 ECTS credit</b>
<b>CM : 4.00 h, CM : 12.00 h, CM : 6.00 h, CM : 2.00 h, TP : 6.00 h, TP : 12.00 h</b>	<b>hand-out in English and course taught in English</b>
<b>Reference Teacher(s) : PREVOTET Jean-Christophe</b>	

**Objectives :**

The objective of this module is to present the issues and basic principles of the security of communicating systems.

**Content :**

The module is composed of three parts. The first part provides basic knowledge in computer and network security while illustrating the course with real use cases. The second part of the module gives the fundamentals in software security by focusing on embedded aspects. Finally, a third part of the module focuses on the hardware security of connected objects by presenting current attacks and planned countermeasures. Practical work will be carried out to implement the acquired concepts on embedded hardware platforms.

**Bibliography :**

The Hardware Hacking Handbook, Jasper van Woudenberg and Colin O'Flynn, no starch press

**Requirements :**

Basic Networks architecture, hardware architectures

**Organisation :**

**Evaluation :**

MCQ -like exam + Lab evaluation

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>Research and Innovation Culture</b>	<b>DET09-IMARS-CRI</b>
<b>Number of hours : 100.00 h</b>	<b>5.00 ECTS credit</b>
<b>CM : 12.00 h, TD : 9.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

Get familiar with research environment and practises. Discover regulatory and legal aspects, research work methodology. Participate in a project focused on the production of new scientific knowledge.

**Content :**

This module is made of three parts. The first one (CVM) addresses the general issue of IP and innovation (patent, publication, start-up creation). It is given by external experts on innovation and value addition. The second one (MR) consists of a bibliographic work, done in small groups, under the supervision of a teacher providing the subject. A fictive journal paper has to be produced and an oral presentation given during an internal mini-conference. The third part (PRJ) is a scientific project, in small groups, aiming at providing a theoretical study supported by relevant simulations/modelizations.

**Bibliography :**

Material produced by students in previous years (available in Moodle).

**Requirements :**

English language. Scientific skills from other modules.

**Organisation :**

**Evaluation :**

1 written exam for CVM (1h). Evaluation of produced material (written paper and oral talk) for MR. Evaluation of produced material for PRJ.

**Target :**

5th year of the Electronics and Telecommunications (E&T) engineer training

<b>TOEIC 5th year</b>	<b>HUM09-ANGL-TOEIC</b>
<b>Number of hours : 20.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 20.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**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

<b>English S9 Conversation</b>	<b>HUM09-ANGL-CONV</b>
<b>Number of hours : 10.00 h</b>	<b>1.50 ECTS credit</b>
<b>TD : 10.00 h</b>	
<b>Reference Teacher(s) : LE VOT Philippe</b>	

**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 :**

<b>Economics, Law and Business Studies A - LEAN MANAGEMENT</b>	<b>HUM09-PM-A</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) :</b>	

**Objectives :**

The Management Course should enable students:  
 to engage with «management-oriented» themes d'aborder des thèmes « orientés métiers » relative to management,  
 to personalise their programme by choosing modules «à la carte», in accordance with their interests and professional projects.

Each student chooses one course from the list of suggested courses.

Beyond the specific skills that are the focus of each course, the learning outcomes can be identified as follows:

to understand and know how to use the specialised vocabulary of management  
 to recognise the main issues in a chosen management theme  
 to practise teamwork: taking decisions collectively and be able to deliver within set deadlines

**Lean Management (28h)**

To master the theoretical concepts and practices of Lean and Six Sigma  
 To develop your capacity to manage and lead value-creating projects  
 To understand the issues of associated with a culture of continuous progress and, by extension, its implementation within an organisation

**Legal Knowledge (6h)**

**Objectives**

To acquire a general knowledge of the law  
 To understand the organisation and main principles of the legal environment

**Content :**

«Lean Management» Course Programme  
 Lean Management (28h)

Lean Management is a structured management method. It is increasingly becoming an approach to improve the performance of companies through improved process efficiency.

Applied to company management, « Lean Management » offers a range of methods to work towards operational excellence.

Associated with the «Six Sigma» methodology which is designed to improve quality, Lean offers an approach that ensures that all customer expectations in terms of quality, deadlines and costs are taken into account.

**Programme**

The content of this course develops and deepens understanding of certain notions seen in the core curriculum for 3rd Year (IMO).

**Introduction to improvement**

DMAIC Project

Organising and Leading a team

specific Lean tools

specific Six Sigma tools

field-oriented Lean and Six Sigma tools

feedback from industry and industrial applications

Students registered in this module will be able to participate in the Hackathon of quality and operational excellence organized in December in Nantes. This event will bring together for a whole day teams made up of 4 to 6 students from several educational institutions from Bac + 2 to Master 2 level, supervised by professionals in operational excellence, QHSE management, continuous improvement ...

Together, the students will have to take up the challenge of responding to a real business problem and proposing a relevant action plan. At the end of the day, each team will pitch their final work. The best presentation will be rewarded with a vote from the public and the jury of experts.

**Legal Knowledge (6h)**

sources of law, the hierarchy of rules, notion of jurisprudence;  
jurisdictions;  
types of law practitioners;  
the contract;  
civil and criminal liability in a company

**Bibliography :**

A specific bibliography on the themes developed is suggested to students in class

**Requirements :**

Eco-Management Modules in S7 and S8

**Organisation :**

The different Management courses bring together students from the various speciality Departments. Each course includes the participation of external speakers (industry professionals, lawyers or consultants). Interactive pedagogy and project work are favoured, with students working in teams on projects that are defined in collaboration with the speakers.

**Evaluation :**

Continuous Assessment: teamwork with oral and/or written assignment

**Target :**

<b>Economics, Law and Business Studies B (Human Resources Management)</b>	<b>HUM09-PM-B</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) : BOUGUENNEC Christelle</b>	

**Objectives :**

Objectives of Management Courses

The Management Course should enable students:

to engage with «management-oriented» themes relative to management,  
to personalise their programme by choosing modules «à la carte», in accordance with their interests and professional projects.

Each student chooses a course from a list of suggested options:

Beyond the specific skills that are the focus of each course, the learning outcomes can be identified as follows:

1. to understand and know how to use the specialised vocabulary of management
2. to recognise the main issues in a chosen management theme
3. to practise teamwork: taking decisions collectively and be able to deliver within set deadlines

Human Resources Management (20h)

This module therefore specifically aims to:

make future engineers aware of individual and collective management  
identify the expectations associated with the manager's mission  
equip students with the tools and techniques suited to the manager's mission

Labour Law (8h)

To make future engineers aware of the right to work by giving them key aspects of comprehension in this area which has been rendered more complex due to the diversity of its origins, the multiplication of reforms and frequent changes in jurisprudence.

To enable future engineers therefore to access the labour market with a concise overview of their rights and obligations within a company

Legal Knowledge (6h)

- To acquire a general knowledge of the law
- To understand the organisation and main principles of the legal environment

**Content :**

«Human Resources Management» Course Programme

Human Resources Management (20h)

Confronted with numerous and ever rapid changes, it is imperative for companies to adapt in order to ensure their sustainability and development. In this context, human management is capital. Leaders must know how to lead, develop and organise the skills of their teams that are necessary to meet objectives and at the same time create commitment in ways that nurture energies sustainably

Programme

the essentials of management  
communication and motivation  
knowing how to set objectives  
leadership and team leadership  
developing teamwork skills  
managing complexity  
supporting change

Labour Law (8h)

background to Labour law

the work contract : study of some essential clauses (workplace, salaries, work hours, non-competitive clause  
some elements on the different types of work contract termination

Legal Knowledge (6h)

- sources of law, the hierarchy of rules, notion of jurisprudence;



- jurisdictions;
- types of law practitioners;
- the contract;
- civil and criminal liability in a company

**Bibliography :**

A specific bibliography on the themes developed is suggested to students in class.

**Requirements :**

Eco-Management Modules in S7 and S8

**Organisation :**

The different Management courses bring together students from the various speciality Departments. Each course includes the participation of external speakers (industry professionals, lawyers or consultants). Interactive pedagogy and project work are favoured, with students working in teams on projects that are defined in collaboration with the speakers

**Evaluation :**

Continuous Assessment: teamwork with oral and/or written assignment

**Target :**

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

**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 :**

<b>Economics, Law and Business Studies D MANAGEMENT AND ETHICS FOR ENGINEERS</b>	<b>HUM09-PM-D</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**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 :**

- The fundamentals of management
  - Ethics and business practices (international and corporate frameworks and regulations, impact on project management and decision processes)
  - Reflexion on personal motivations related to social and environmental impact of innovation and business, personal values vs professional goals)
- Transversal approach by industry sector case studies

**Bibliography :**

Given during the course

**Requirements :**

NONE

**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 :**

<b>Economics, Law and Business Studies E (INTERNATIONAL DEVELOPPEMENT &amp; STRATEGIES)</b>	<b>HUM09-PM-E</b>
<b>Number of hours : 34.00 h</b>	<b>2.00 ECTS credit</b>
<b>CM : 30.00 h, TD : 4.00 h</b>	
<b>Reference Teacher(s) : GOURRET Fanny</b>	

**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

**Bibliography :**

Given during the course

**Requirements :**

None

**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 :**

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

**Objectives :**

Sustainable Development (28h)

Sustainable development is a major societal issue that challenges all stakeholders, including training and research institutions. The INSA group has taken up this theme and actively engages with the ways and means of "training engineers to a very high technical level... [but who are also] aware of today's global challenges & capable of helping their companies to make their own energy and ecological transition "(Inter-INSA Energy-Climate Challenges Working Group in engineer training).

INSA Rennes has committed to the SDSR (Sustainable Development and Social Responsibility) accreditation process. The Engineering students enrolled in Course F will be able to contribute concretely to this process by presenting projects that meet the requirements of this standard, in collaboration with the COPIL-DD (Sustainable Development Piloting Committee) and the CRIC-DD (Rennes Inter-Campus Collective for Sustainable Development).

**Objectives**

- To deepen your knowledge of SDS issues and be able to raise awareness of them;
- To understand the SD standards and the stages of the accreditation process;
- To build a team project that serves the accreditation of INSA Rennes ;
- To know how to convince others of your project's relevance and to assess its feasibility (technical and economic)

**Legal Knowledge (6h)**

**Objectives**

- To acquire a general knowledge of the law
- To understand the organisation and main principles of the legal environment

**Content :**

**Programme**

Presentation of COPIL-DD (Sustainable Development Piloting Committee), CRIC-DD (Rennes Inter-Campus Collective for Sustainable Development) and SD-SR accreditation  
 Conferences on SD: environmental impacts of digital technology , biodiversity and gardens, SSS (Social et Solidarity Space), etc.  
 Training on the «Fresco for the Climate» tool

**Legal Knowledge (6h)**

**Programme**

sources of law, the hierarchy of rules, notion of jurisprudence;  
 jurisdictions;  
 types of law practioners;  
 the contract;  
 civil and criminal liability in a company

**Bibliography :**

A specific bibliography on the themes developed is suggested to students in class

**Requirements :**

Eco-Management Modules in S7 and S8

**Organisation :**

The different Management courses bring together students from the various speciality Departments. Each course includes the participation of external speakers (industry professionals, lawyers or consultants). Interactive pedagogy and project work are favoured, with students working in teams on projects that are defined in collaboration with the speakers

As part of this module, the student engineers:

- will attend conferences on SD themes
- will be trained on how to use the «Fresco for the Climate» tool

- will work in pluridisciplinary teams to develop a project that is eligible for SD-SR accreditation and can be implemented on campus.

Personal study time will be provided for within the schedule in order to allow students to advance with the team projects

**Evaluation :**

Continuous assessment (collective work)

**Target :**

Semestre 10

Contrat de Professionnalisation

1	DET10-1		Internship	30.00
	DET10-PFE	O	Work placement	30.00

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

<b>Work placement</b>	<b>DET10-PFE</b>
<b>Number of hours : 350.00 h</b>	<b>30.00 ECTS credit</b>
<b>ST : 350.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 Formation Initiale E&T**

<b>1</b>	<b>DET10-1</b>		<b>Internship</b>	<b>30.00</b>
	DET10-PFE	O	Work placement	30.00

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

<b>Work placement</b>	<b>DET10-PFE</b>
<b>Number of hours : 350.00 h</b>	<b>30.00 ECTS credit</b>
<b>ST : 350.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 S9 EXT - S10 PFE**

<b>1</b>	<b>DET10-1</b>		<b>Internship</b>	<b>30.00</b>
	DET10-PFE	O	Work placement	30.00

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

<b>Work placement</b>	<b>DET10-PFE</b>
<b>Number of hours : 350.00 h</b>	<b>30.00 ECTS credit</b>
<b>ST : 350.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 5ET+Master**

<b>1</b>	<b>DET10-1</b>		<b>Internship</b>	<b>30.00</b>
	DET10-PFE	O	Work placement	30.00

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

<b>Work placement</b>	<b>DET10-PFE</b>
<b>Number of hours : 350.00 h</b>	<b>30.00 ECTS credit</b>
<b>ST : 350.00 h</b>	
<b>Reference Teacher(s) :</b>	

**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 :**