INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES

Academic year 2023/2024

Courses offered by the programme

Génie Physique et Matériaux (GPM)

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 pedagocial activities (DIV). Some internships (stages (ST)) are compulsory

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

Code	Libelle
GPM07-TPMA	LABORATORY : MATERIALS 1
GPM07-TPMA RI	LABORATORY : MATERIALS 1 - RI
GPM08-TPMA	LABORATORY : MATERIALS 2
GPM08-TPMA RI	LABORATORY : MATERIALS 2 – RI
GPM09-ENER	Renewable Energy
GPM09-MAVA	Advanced Materials Science
GPM09-SAP	Searching and analysing patents

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

INSA RENNES - Génie Physique et Matériaux (GPM) : 2023/2024

Semestre 5

Parcours Formation Initiale GPM

1	**GPM05-1**		**Physics 1**	**4.50**
	ESM05-ANAL	O	Mathematical Analysis for the Engineer	1.50
	ESM05-MATLAB	O	Initiation Matlab	1.00
	ESM05-SIG	O	Signals and Systems	2.00
	GPM05-SMATH	F	Soutien Mathématiques	0.00
2	**GPM05-2**		**SCIENCES PHYSIQUES 1**	**6.00**
	GPM05-POMI	O	Wave propagation 1	3.00
	GPM05-TP	O	Travaux Pratiques S1	2.50
	GPM05-CONF	O	Conferences	0.50
3	**GPM05-3**		**Instrumentation & Measurement**	**4.50**
	GPM05-IM	O	Instrumentation and measurements	4.50
4	**GPM05-4**		**SCIENCES DES MATERIAUX 1**	**8.00**
	GPM05-MQ	O	Quantum Mechanics	3.00
	ESM05-MAT	O	METALLIC MATERIALS	2.00
	GPM05-PM	O	Polymers	1.50
	GPM05-COMP	O	Composites	1.50
5	**HUM05**		**Non-scientific syllabus S5**	**7.00**
	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
6	**HUMF1-RIE**		**RIE : Recherche Innovation Entrepreneuriat**	**1.00**
	HUMF1- RI	F	Recherche Innovation	1.00
	HUMF1- IE	F	INNOVATION & ENTREPRENEURSHIP	1.00
7	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00
11	**HUMF1-ELSA Thea**		**Theatre with studies**	**1.00**
	HUMF1-THEA	F	Study & Theater	1.00

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

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

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

Initiation Matlab	ESM05-MATLAB
Number of hours : 12.00 h	1.00 ECTS credit
CM : 2.00 h, TP : 10.00 h	
Reference Teacher(s) : PEDESSEAU Laurent	

Objectives :
- Transfer the basic pedagogical support needed for the use of Matlab code.
- Matrix calculation and also the use of Simulink applying to realistic problems
- Assimilate the basic concepts of “script” and “function”
- Be familiar with the method fft and also the “ode” method to solve various problems in materials science, solid state physics, flow mechanics, quantum mechanics, heat flux, electromagnetic, semiconductor.

Content :
Introduction, generalities, Matrix calculation, read and write in a file, Basic starting to solve problem with Simulink.

Bibliography :
- Kelly Bennett: MATLAB Applications for the Practical Engineer. InTech 2014.
- Wikibooks 2012: MATLAB Programming. http://en.wikibooks.org/wiki/MATLAB_Programming
- Subhas Chakravarty: Technology and Engineering Applications of Simulink. InTech 2012

Requirements :
Algebra, Matrix calculation, numerical analysis, simulation.

Organisation :
10 h of training + 2h of amphitheater

Evaluation :
Exam 1h + proceeding of the training.

Target :

Signals and Systems	ESM05-SIG
Number of hours : 28.00 h	2.00 ECTS credit
CM : 14.00 h, TD : 14.00 h	
Reference Teacher(s) : KPALMA Kidiyo	

Objectives :
Introduction and application of all the necessary mathematical tools to better understand electronics, control and signal processing. The applications are illustrated with simple examples taken from those disciplines.

Targeted competences are:
-> Understand the concept of a signal and know how to modelize it,
-> Understand what is a system and predict its behaviour face to an input signal,
-> Understand mathematical tools needed to electronics, control and signal processing

Content :
1. Overview of signals: signals described by functions and signals described by distributions. Deterministic and random signals. Classification of deterministic signals depending on their time variation (discrete or continuous), test signals (pulse, step, sinusoid, etc.)

2. Overview of systems: definition, system response and convolution. Linear system response to a sinusoidal input or to a non-sinusoidal periodic input (Fourier series).

3. Fourier series, Fourier and Laplace transforms - Definitions, spectral representation of a signal, properties of transformations, transforms of some usual signals. Notions of power spectral density (psd) and energy spectral density (esd). Wiener–Khinchin theorem.

4. Response of a linear system to any input. Application of the Laplace transform to the study of the response of a linear system subject to any input. Isomorph transfert function and spectral representation. Study of the stability (definition, the stability and poles location, stability of looped systems)

Bibliography :
1. BLOT J., "Electronique linéaire - cours", Chapitre 2, Dunod Université, 1993.
2. BOITE R., NEIRYNCK J., "Traité d'électricité, Théorie des réseaux de Kirchhoff", Georgi.
3. BORNE P., DAUPHIN-TANGUY G., RICHARD J. P., ROTELLA F., ZAMBETTAKIS I., "Automatique, Analyse et régulation des processus industriels", Tome 1, Tecnip.
4. COULON F., "Traité d'électricité, Théorie et traitement des signaux", Georgi.

Requirements :
None

Organisation :
Revision of lecture notes. Review of basic mathematics. Preparation of exercises. Active learning: participation in problem solving on the board.

Evaluation :
One-hour quizz (Moodle) in the middle of the semester (without documents) and a two-hour written examination (with documents) at the end of the semester.

Target :
3EII, 3GPM, 3GMA.

Soutien Mathématiques	GPM05-SMATH
Number of hours : 9.00 h	0.00 ECTS credit
TD : 9.00 h	
Reference Teacher(s) : LEY Olivier	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Wave propagation 1	GPM05-POMI
Number of hours : 44.00 h	3.00 ECTS credit
CM : 17.00 h, TA : 21.00 h, TD : 5.00 h	
Reference Teacher(s) : ROBINET Sylvie	

Objectives :
The fundamentals of how to understand and represent propagation of electromagnetic waves in linear, isotropic, homogeneous, infinite or confined environments. _The module is taught with active pedagogy, via an e-learning platform (Moodle), with question and answer weekly sessions and auto-evaluation. This develops the student's organisation and autonomy

Content :
- Propagation of electromagnetic waves in linear, isotropic, homogeneous environments._- Polarisation of electromagnetic waves (Jones 's vectors)._- Reflection and transmission at an interface between two media (Fresnel equations)._- Homogeneous transmission lines applied to hyperfrequency : active power transferred to a load, reflexion coefficient, Smith chart with TEM waves in coaxial guides._- Propagation modes TE and TM in metal guides with rectangular section.

Bibliography :
- C. FRERE et P. KREMPF "Physique des Ondes" (2e`me anne´e PC - PC*, PSI, PSI*) Ellipses - J.P. PEREZ et Coll. "Electromagne´tisme", Masson (3e`me e´dition)_- S. HUARD "Polarisation de la lumie`re", Masson_- M. HULIN et coll. "Equations de Maxwell : Ondes e´lectromagne´tiques". Dunod
- J.P. FAROUX et J. RENAULT "Electromagne´tisme 2". Dunod - P.F. COMBES, "Ondes me´triques et centime´triques", Dunod Universite´_- G. DUBOST, "Propagation des ondes e´lectromagne´tiques". Masson.

Requirements :
Maxwell equations, Theory of linear electrical networks using a sine wave, Electromagnetism.

Organisation :
Revision of lecture notes. Completion of the exercises (2hrs per week) and quiz via the platform Moodle.

Evaluation :
2 written examinations of 1hr30 and 2hrs respectively.

Target :

Travaux Pratiques S1	GPM05-TP
Number of hours : 24.00 h	2.50 ECTS credit
TP : 24.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Conferences	GPM05-CONF
Number of hours : 15.00 h	0.50 ECTS credit
CONF : 15.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
Professionals from a wide range of companies hold conferences on the various career options open to students in the MNT
department. The guest speakers describe their companies' engineering work and market structure. The aim is to help students in
their choice of career.

Content :
Career guidance through conferences.

Bibliography :

Requirements :

Organisation :

Evaluation :
Signed attendance sheets.

Target :

Instrumentation and measurements	GPM05-IM
Number of hours : 65.50 h	4.50 ECTS credit
CM : 19.50 h, PR : 13.00 h, TA : 3.00 h, TP : 27.00 h	
Reference Teacher(s) : PARANTHOEN Cyril	

Objectives :
Bring students the basics of a whole measurement set-up (from the sensor, the measurement and the acquisition software)._Introduction to noises and its origin, and to specific set-up to increase signal to noise ratio.
Initiation to Labview acquisition software (Core I), in order to pass certification, considering Labview Academy partnership.

Content :
Teaching is organized with courses and exercises and related practical works (3 hours), ending with a small project (5 practical work sessions)._Program :_- Overview of the architecture of a calculator._- Overview of computer- instrument communication interfaces : RS232, RS485, GPIB, USB and RJ45._- Sensors and associated electronics_- Functions of a data acquisition card (analogical-numerical and numerical-analogical conversion of signals, sampling)_- Overview of measurement noises and its origin (thermic, Jonhson, Flickers), electronic noise equivalence and association, specific set-up for increasing signal/noise ratio (modulation, lock-in detection) and its applications._- Initiation to Labview acquisition software, in order to get the basics of the certified formation module labelled as Core I.
- Implementation of acquired basics through small projects. These projects aim to acquire several signals, in order to fulfil specifications and extract specific parameters.

Bibliography :
- D. Patterson, J. Hennessy, "" Organisation et conception des ordinateurs : interfaçage matériel/logiciel "", Dunod 1994 - F.
Cottet "" Traitements des signaux et acquisition de données "", Dunod 2002 - G. Ash "" Acquisition de données : du capteur à l'ordinateur".

Requirements :
Basic electronics.

Organisation :
Review of lecture notes. Preparation for the practical work (Summary required for each session: 1h per week).

Evaluation :
2hr written examination(documents allowed).
Evaluation mark on a small project (5 practical work sessions).

Target :

Quantum Mechanics	GPM05-MQ
Number of hours : 40.00 h	3.00 ECTS credit
CM : 20.00 h, TD : 20.00 h	
Reference Teacher(s) : CORNET Charles, EVEN Jacky, PEDESSEAU Laurent	

Objectives :
Basic and advanced concepts of quantum mechanics

Content :
Introduction to Quantum Mechanics: Wave-particle Duality, Energy Quantification, Wave Function, Schödinger equation
Formulation of Quantum Mechanics: State representation by "kets" and "bras", Operators, Observables, Measurement, Commutation, Ehrenfest equation and link with classical mechanics
Modern approach to quantum mechanics. Qubits, intrication, decoherence.
Introduction to quantum technologies, and quantum computing.

Bibliography :
C. COHEN-TANNOUDJI, B. DIU et F. LALOE, "Mécanique Quantique" tome I, II, III

Requirements :
Mathematics of the first two years at INSA (or equivalent).

Organisation :
Three hours per week on the average.

Evaluation :
Two-hours written final examination. Short mid-semester evaluation.

Target :

METALLIC MATERIALS	ESM05-MAT
Number of hours : 28.00 h	2.00 ECTS credit
CM : 14.00 h, TD : 14.00 h	
Reference Teacher(s) : CORNEN Marilyne	

Objectives :
The first aim of this lecture is to introduce the science of metallic materials, that means metallurgy, through the discovery of iron based alloys (steels and cast-iron). Students will also learn some details about iron and steel industry. Then, an important point is to learn how to predict the materials microstructures by reading binary diagrams. To go further with metallurgical considerations, some attention will be paid to non-equilibrium diagrams such as TTT or TRC curves (steels). Some information will be given about thermal treatments of metallic alloys and the learning of metallurgy will be extent to others alloys such as Al based alloys, Cu based alloys and Ni based alloys.

Content :
_ Introduction
_ Iron and Steel industry
_ Binary diagrams : Fe-C & Fe-Fe3C
_ Typical microstructures of steels and associated transformations
_ Standards of iron based alloys
_ Thermal treatments of steels
_ Cast irons
Others : Cu/Al/Ni alloys.

During half classroom work sessions (TD) the main notions will be applied to better understand what has been explained during the lectures (vocabulary, calculations, how to use and read the binary diagram, how to predict the microstructure, recognize and identify phases on micrographs, …).

Bibliography :
http://www.construiracier.fr/tout-sur-lacier/
« Précis de métallurgie » J. Barralis et G. Maeder
« Métallurgie, du minerai au matériau » J. Philibert, A. Vignes, Y. Bréchet, P. Combrade
« Précis des matériaux, de la conception aux contrôles », M. Dequatremare, T. Devers
« Aide-mémoire de Sciences des matériaux » M. Dupeux
« La microstructure des aciers et des fontes : genèse et interprétation » M. Durand-Charre
Techniques de l'ingénieur : M 1 110, M 1 115, TBA 1050, TBA 1054, etc.
AFNOR
« Atlas des courbes de transformations », IRSID

Requirements :
Notions of cristallography and thermodynamics.

Organisation :
1 to 2 hours per week in order to learn a very specific and technic vocabulary. Try to draw by yourself the predicted microstructures, training to diagram reading.

Evaluation :
1 written exam, duration :2h.

Target :

Polymers	GPM05-PM
Number of hours : 10.00 h	1.50 ECTS credit
CM : 10.00 h	
Reference Teacher(s) : GUILLOU Olivier	

Objectives :
General knowledge of polymers. Relationships between chemical composition and physical properties. Study of the relationship between formation and composition of polymers. Study of the mechanical behaviour of polymers.

Content :
Overview of Polymers.
Basics of polymer chemistry (synthesis, additives).
Structure and physical properties of polymers.
Monographs of various polymers (properties and applications).
Formation of polymers.
Rheology models.
Non-ageing linear viscoelasticity.

Bibliography :

Requirements :
Basic knowledge of general chemistry and organic chemistry. General metallurgy, continuum mechanics.

Organisation :
Sixty to ninety minutes per week.

Evaluation :
One-hour written examination.
Target :

Target :

Composites	GPM05-COMP
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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 healt
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 healt
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 10/20for 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 :

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

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 :

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

Objectives :
Conduct a rigorous and synthetic reflection on a given topic dealing with one subject of interest developped 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 bibiography
- 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 :

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

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 :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

INNOVATION & ENTREPRENEURSHIP	HUMF1- IE
Number of hours : 8.00 h	1.00 ECTS credit
TD : 8.00 h	
Reference Teacher(s) :	

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 :

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

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

Study & Theater	HUMF1-THEA
Number of hours : 27.00 h	1.00 ECTS credit
TD : 27.00 h	
Reference Teacher(s) : MERIC Stephane	

Objectives :
Initiation and/or improvement of acting based on a theatrical artistic training which is built from the writing act to the stage.

Content :
In partnership with ADEC-House of amateur theater of Rennes, the "Study&Theater" section is dedicated to students who wish to learn or improve in dramatic play. the section offers training modules with professional artists. In line with its annual program, ADEC, in close collaboration with the Head of the "Study and Theater", builds a theatrical artistic journey, grom writing to the stage along four successive semesters with four different artists.

The recruitment of "Study & Theater" section is carroed out every two years to constitute a promotion of 15 students registering on an artistic journey of a duration of 2 years. The "Study & Theater" section is open to all engineering students, no prerequisites and enrolled at INSA Rennes between the first year and third year. Each student engineer registered in this section is commited to following the training provided over the term of two years. An evaluation at the end of each semester of the course is completed by the head of the section.

Since September 2017, a professional theater company, with a creation and training link with ADEC, has offered an artistic universe to promote the current year. The work is done either around a theatrical work or around an original work from materials (writing work, text editing work). In general, during this first semester, the set work takes up the basics of acting for addressing the artistic propositions. In addition to this course, the ADEC offers two interventions around the discovery of theatrical literature at the ADEC library and some slight initiations to the light operations.

Bibliography :

Requirements :
no specific acting requirement

Organisation :
On Thursday afternoon at the ADEC theater place

Evaluation :
Validation based on the student's involvement

Target :
Registered student between the first and third year

Semestre 6

Parcours Formation Initiale GPM

1	**GPM06-1**		**Physics 2**	**5.00**
	GPM06-POMA	O	Wave propagation 2	2.00
	GPM06-CONF	O	Conferences - company visit week	0.50
	GPM06-TP	O	Physics - Practical work	2.50
2	**GPM06-2**		**Material science**	**5.00**
	GPM06-TM	O	Thermodynamic Properties of Materials	3.00
	GPM06-CN	O	CORROSION	1.00
	GPM06-CERA	O	CERAMICS	1.00
3	**GPM06-3**		**Wave and Materials**	**5.50**
	GPM06-PS	O	Solid State Physics	3.00
	GPM06-SC	O	Physics of semiconductor devices	2.50
4	**GPM06-4**		**Electronics**	**7.50**
	ESM06-AUTO	O	Control Systems Engineering	3.00
	GPM06-ELEC	O	ELECTRONICS : CIRCUITS AND SEMICONDUCTOR DEVICES	4.50
5	**HUM06**		**Non-scientific syllabus S6**	**7.00**
	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

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

Wave propagation 2	GPM06-POMA
Number of hours : 24.00 h	2.00 ECTS credit
TD : 24.00 h	
Reference Teacher(s) : DURAND Olivier	

Objectives :
Propagation phenomena. An overview of applications in optics, optoelectronics and electromagnetism.

Content :
Digital information transmission. Limits.
Waveguide characteristics: metallic guides, coaxial cables, microstrip lines, optical fibres.
Polarisation effects: natural and induced birefringence. Applications which result in the Pockels, Kerr or Faraday effects;
Liquid crystals.
Propagation of plane waves. Application in a multilayer environment, in a Fabry-Perot cavity. Mechanical vibrations in solids.
Physical phenomena linked to Phonons.

Bibliography :
- G. BRUHAT ""Optique"", Masson, Paris.
- M. BORN and E. WOLF, ""Principles of optics"", Pergamon Oxford.
- B.E.A.SALEH and M.C. TEICH, ""Fundamentals of Photonics"", John Wiley et Sons inc. New-York.
- J.Ph. PEREZ, ""Optique"", Masson.
- J.Ph PEREZ, ""Electromagnétisme", Masson.

Requirements :
Knowledge of Maxwell's equations, of the theorem of linear electric networks and of cissoids.

Organisation :
Revision of lecture notes. Completion of exercises (3 hours per week).

Evaluation :
Two-hour written examination.

Target :

Conferences - company visit week	GPM06-CONF
Number of hours : 14.00 h	0.50 ECTS credit
CONF : 14.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
Professionals from a wide range of companies hold conferences on the various careers open to students in the MNT
department. The speaker describes his companies' engineering work and market structure. Students must organise an activity
week "semaine blanche" dedicated to visiting companies either in France or abroad. Participation is compulsory and a
collective report must be written. The objective is to prepare students for job seeking and familiarise them with company
practices. This module, once validated, gives 1 ECTS credit.

Content :
Attendance at conferences.
Organising and participating in the company visit week "semaine blanche".

Bibliography :

Requirements :

Organisation :

Evaluation :
Validation depends on:
Involvement in the company visit week.
Signed attendance sheets for the conferences.

Target :

Physics - Practical work	GPM06-TP
Number of hours : 24.00 h	2.50 ECTS credit
TP : 24.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Thermodynamic Properties of Materials	GPM06-TM
Number of hours : 30.00 h	3.00 ECTS credit
CM : 16.00 h, TD : 14.00 h	
Reference Teacher(s) : GLORIANT Thierry	

Objectives :
Basics of Thermodynamics as preparation for the lectures on materials. Topics: equilibrium in binary systems, material/environment interactions, processing and transforming process, thermodynamic model of metallic, ceramic and
semiconductor systems.

Content :
Thermodynamic systems and functions (Reminder).
Partial and integral molar quantities, activities and thermodynamic activity coefficients.
Binary solutions, binary solution models, quasi-chemical approach of solid solutions.
Thermodynamics and equilibrium diagrams of a binary system. Practical determination of thermodynamic quantities.
Utilisation of thermodynamic databases.
Overview of models for thermodynamics of materials.

Bibliography :
- A. PRINCE, ""Alby phase equilibra"" (1966) Elsevier Publishing Company - R.A. SWALIN, ""Thermodynamics of solids"" (1962) John Wiley and Sons, New-York.
- N.A. Gokcen, ""Thermodynamique"" (Traduction française) CIRP (Saint Denis).

Requirements :
Thermodynamics - Bachelor level (Physics and Chemistry).

Organisation :
Revision of lecture notes. Completion of exercises (two - three hours per week).

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

Target :

CORROSION	GPM06-CN
Number of hours : 11.00 h	1.00 ECTS credit
CM : 11.00 h	
Reference Teacher(s) : GORDIN Doina-Margareta	

Objectives :
Basics of wet and hot corrosion.

Content :
- Corrosion phenomena and morphology.
- Electrochemistry (Reminder): electrode potential and batteries, Pourbaix diagrams.
- Laboratory study methods: intensity-potential graphs, polarisation resistance, measuring of complex impedance.
- Corrosion situations: galvanic corrosion, differential airing corrosion, pitting corrosion, stress corrosion.
- Protection against corrosion: choice of materials, coatings, cathodic or anodic protection.
- Hot gas corrosion.

Bibliography :
- J. PHILIBERT A. VIGNES Y. BRECHET P. COMBRADE " Métallurgie du minerai au matériau " Ed Masson.
- D. LANDOLT " Corrosion et chimie de surfaces des métaux ", Ed. Presses .Polytechniques et Universitaires Romandes.
- J.J. LAMOUREUX "Précis de corrosion " Ed. Masson.
- J.C. SCULLY " Corrosion Protection : principes fondamentaux " Ed. Masson.
- C. VARGEL " Corrosion de l'aluminium ", Ed. Dunod.

Requirements :
Electrochemistry (as studied during the first two years at INSA).

Organisation :
Sixty to ninety minutes per week.

Evaluation :
One-hour written examination.

Target :

CERAMICS	GPM06-CERA
Number of hours : 14.00 h	1.00 ECTS credit
CM : 12.00 h, TD : 2.00 h	
Reference Teacher(s) : GLORIANT Thierry	

Objectives :
Essential knowledge of ceramic materials: processing methods and physical properties.

Content :
Definition. General overview. Classification of ceramics. Traditional and technical ceramics.
Examples of simple and complex ceramics.
Ceramic processing: sintering. Definition of the different stages of sintering.
Processing procedures by deposition (CVD, PVD).
Physical mechanisms of the mechanical behaviour of ceramics: ductility, frailty, stress intensity factor, creep mechanisms.
Electric, magnetic and thermal properties.

Bibliography :
W.D. KINGERY, H.K. BOWEN, DR UHLMANN, Introduction to Ceramics, John Wiley et Sons, New-York (1976), ISBN
0.471.47860.1
J.L. CHERMANT, Caractérisation des poudres et des céramiques, Hermès, Paris (1992), ISBN 2.86601.307.7
L.L. HENCH, R.W. GOULD, Characterization of Ceramics, M. Dekker Inc, New-York (1971), ISBN 0.8247.1302.8

Requirements :
Basic knowledge in Crystallography. Materials Thermodynamics. Structural Metallurgy.

Organisation :
One hour per week.

Evaluation :
One-hour written examination.

Target :

Solid State Physics	GPM06-PS
Number of hours : 34.00 h	3.00 ECTS credit
CM : 16.00 h, TD : 18.00 h	
Reference Teacher(s) : BOYER Soline, GUEZO Maud	

Objectives :
This module fundamentally deals with crystal lattices and the electronic properties of solids, leading to semiconductor band
structure.

Content :
Symmetries and special lattices: seven crystal systems and fourteen Bravais lattices. Basic lattices: simple cubic, body-centred,
face-centred, diamond and zincblende structure. Reciprocal lattice: base, cubic lattice, body-centred, face-centred, Brillouin
zone, Bloch theorem, from direct to reciprocal lattice, BvK conditions. Electrons in a solid: linear crystal, free electron,
nearly-free electron, Brillouin zone. Bonding in a crystal: covalent bond, hybridisation. Orbital hybridisation: interaction and
crossing of levels. Filling of the levels. First evaluation of band gap. Band calculation with the tight binding approximation:
Secular equation in the diamond system. Band structure, gap and filling in of bands at 0K, Cohesion energy. Overview of real
bands: wave function symmetries, band gaps, valence and conduction bands, description of the zone-centre.

Bibliography :
Polycopiés de cours : S. Loualiche; Polycopiés de TD et TP
H. Mathieu, Physique des semiconducteurs et des composants optiques (Masson)
J. Singh, Optoelectronics , McGraw Hill Book Co
Ashcroft, Mermin, Solid State Physics (sauders company)

Requirements :
In mathematics:
3D differential equations, Space geometry, Calculation of Eigenvalues and eigenvectors.
Basic knowledge of wave functions and projections of an operator on a base.
3D Fourier transform.
In other fields:
Plane waves, overview of atomic orbitals, electrostatics and electromagnetism.

Organisation :
Revision of lecture notes. Preparation of exercises (three hours per week).

Evaluation :
1 written and 1 practical examination.

Target :

Physics of semiconductor devices	GPM06-SC
Number of hours : 30.00 h	2.50 ECTS credit
CM : 14.00 h, TD : 16.00 h	
Reference Teacher(s) : BERTRU Nicolas, LEVALLOIS Christophe	

Objectives :
The band structure of a solid is used to develop and to understand its electronic properties. It is also used to in optoelectronic
devices such as diodes or pn junctions.

Content :
Electron dynamics in a solid: Moment and group velocity, Acceleration theorem in reciprocal space, Effective mass and
acceleration in a real space. Density of states in a solid: Fermi statistics, "hole" concept, energy level occupation, impurities
and Fermi level. Concentration of carriers depending on temperature. Transport: Boltzmann's equation, conduction, diffusion,
general equations. Hall effect: metal, insulator, semiconductor. Hall effect with one or two types of carriers. Recombination
and generation processes: SRH laws (Shockley Read Hall). High and low carrier injection cases. Continuity equations in a
solid, equations for diffusion of minority carriers. PN junction: energy bands, built in potential of the junction. Approximation
of the depleted zone. Direct and inverted polarisation of the pn junction. Current voltage characteristics of the pn junction at
equilibrium and under voltage polarisation. I-V characteristics of a thin diode. Electric properties of the pn junction: capacitance and conductance. Schottky diode : Metal work function and electronic affinity. I-V characteristics of a Schottky
diode.

Bibliography :
Preprinted lecture aids: S. Loualiche ; Polycopiés de TD et TP
H. Mathieu, Physique des semiconducteurs et des composants optiques (Masson)
J. Singh, Optoelectronics , McGraw Hill Book Co
Ashcroft, Mermin, Solid State Physics (sauders company)

Requirements :
In mathematics: 3D differential equations, Space geometry.
In other fields: Plane waves, overview of atomic orbitals, electrostatics and electromagnetism.

Organisation :
Revision of lecture notes. Preparation of the exercises (three hours per week).

Evaluation :
1 written and 1 practical examination.

Target :

Control Systems Engineering	ESM06-AUTO
Number of hours : 40.00 h	3.00 ECTS credit
CM : 14.00 h, TD : 14.00 h, TP : 12.00 h	
Reference Teacher(s) : GUEGAN Sylvain	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

ELECTRONICS : CIRCUITS AND SEMICONDUCTOR DEVICES	GPM06-ELEC
Number of hours : 66.00 h	4.50 ECTS credit
CM : 18.00 h, PR : 12.00 h, TD : 18.00 h, TP : 18.00 h	
Reference Teacher(s) : BECK Alexandre	

Objectives :
At the end of this course, you should be able to:
• Understand and analyse operational amplifier-based circuits
• Design a filter template and the circuit that achieves this function (active and passive devices)
• Understand and know the operating principles of the main semiconductor-based electronic devices (Junction diode, bipolar transistor (BJT), MOS transistor and field effect transistor)
• Know the basic current-voltage relationship of these devices
• Bias an active electronic circuit
Determine and analyze small-signal equivalent circuit of single and multi-stage amplifier

Content :
1.Linear amplification : amplifier function, operational amplifier (op-amp), real op-amp characteristics, basic op-amp circuits, controlled voltage and current sources
2.Analog filters: Filter template and design, transfer function, Bode diagram, order, filter implementation
3.Semiconductor active devices : Diode, bipolar junction transistors, field effect transistors, MOSFET (operating principles, current-voltage characteristics)
4.Linear semiconductor devices and amplifier circuits: Biasing, small-signal equivalent circuit at steady state
5.Amplification : single stage and multistage amplification, fundamental circuits, impedance matching
6.Differential pair: operating principle, Common and differential mode in large signal and small-signal approximation, main characteristics

Bibliography :
SEDRA/SMITH, Microelectronic circuits, Oxford (in English)
F. Manneville/J. Esquieu Electronique tomes 1 et 2, Dunod (French)
J. Blot, Electronique linéaire, Dunod (French)
A.P. Malvino/D.J. Bates, Principes d'électronique, Dunod (French)

Requirements :
Basic knowledge of electrical engineering. Linear electrical circuits in continuous wave regime

Organisation :
The lectures (1h30/week for a total of 18h) will give the necessary information for practical works related to the course. Practical exercises will be proposed during tutorials (for a total of 18h) in close relation with the lecture. Devices and circuits studied during lectures will also be investigated experimentally during laboratory works.

Evaluation :
At the end of the course:
A written examination on the lectures and tutorials (2h)
Lab works will be evaluated too (reports and final examination) and integrated to the final mark.

Target :

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

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 (produiction 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 :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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 :

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

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 :

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

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 :

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

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

Semestre 7

Parcours Formation Initiale GPM

1	**GPM07-1**		**Materials Science 1**	**11.00**
	GPM07-CRIS	O	Crystallography	3.00
	GPM07-DRX	O	Structural analysis of materials by X-RAY scattering and diffraction	3.00
	GPM07-MECA	O	Mechanics and forming of materials	3.50
	GPM07-TPMA	C	LABORATORY : MATERIALS 1	1.50
	GPM07-TPMA RI	C	LABORATORY : MATERIALS 1 - RI	1.50
2	**GPM07-2**		**Electronic Devices Technology 1**	**9.00**
	GPM07-ELEC	O	ELECTRONIC FUNCTIONS	4.00
	GPM07-DISP	O	Semiconductor devices	3.50
	GPM07-TPPED	C	Electronic and opto.properties of Solid - based devices	1.50
	GPM07-TPPED RI	C	Electronic and opto.properties of Solid - based devices - RI	1.50
3	**GPM07-3**		**Science and Technology**	**4.00**
	GPM07-MOD	O	Modelling	2.00
	GPM07-PLAN	O	Design of experiments methodology	1.50
	GPM07-CONF	O	Conferences	0.50
4	**HUM07**		**Non-scientific syllabus S7**	**6.00**
	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
7	**GPMF1-RI**		**Parcours RI S7**	**1.50**
	GPM07-RI	F	Initiation à la recherche	1.50
8	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00

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

Crystallography	GPM07-CRIS
Number of hours : 24.00 h	3.00 ECTS credit
CM : 12.00 h, TD : 12.00 h	
Reference Teacher(s) : CASTANY Philippe	

Objectives :
Understanding the concepts of crystallography.

Content :
- Reminders of geometric crystallography: direct lattice, motif, reciprocal lattice, Miller indices, close-packed structures and examples of structures.
- Stereographic projection: use in crystallography, representation of directions and planes, Wulff net, operations (angle measurement, rotations).
- Symmetries in crystals: symmetry operations and elements, point groups, crystal classes, crystal systems, Bravais lattices, space groups, international tables of crystallography.

Bibliography :
- M. De Graef, M.E. McHenry, Structure of materials, Cambridge University Press (2007).
- D. Swarzenbach, G. Chapuis, Cristallographie, Presses Polytechniques et Universitaires Romandes, Lausanne (2006).
- J.J. Rousseau, Cristallographie geòomeòtrique et radiocristallographie, Dunod, Paris (2000).

Requirements :
General knowledge of the structure of materials (bachelor level).

Organisation :
Alternation between presentation of theoretical concepts (cours) and concrete applications (TD)

Evaluation :
Two-hours written examination.

Target :

Structural analysis of materials by X-RAY scattering and diffraction	GPM07-DRX
Number of hours : 27.00 h	3.00 ECTS credit
CM : 17.00 h, TD : 10.00 h	
Reference Teacher(s) : FILLON Amelie	

Objectives :
General knowledge of the interference pattern and diffraction of X-rays scattered by crystals.
Basics of radiocrystallography X techniques.
Materials characterization: from bulk properties to thin film characterization.
To explore possibilities available in Synchrotron sources and methods (X and neutrons).

Content :
Mrs A. Fillon's intervention
Production of X-rays. Fundamental interactions of radiation with matter.
Introduction to diffraction theory. Basics of X-ray scattering and diffraction. From electron scattering to structure factors.
Applications of X-rays diffraction by crystals. Laboratory methods: Laue method, powder diffraction, Debye Scherrer diffraction, rotating crystal method, Bragg Brentano geometry.
Experimental procedures: identification of crystalline phases and orientation, determination of lattice parameters, strain, grain size, phase composition, preferred orientation.
From structure factors to measured intensities: kinematic versus dynamic diffraction, multiplicity, polarisation factor, Lorentz factor, absorption and temperature effects.

Mr O. Durand's intervention
X-ray scattering on thin layers.
X-ray diffraction and reflectometry: thickness measurements, microstructural characterization, microstrains, strain determination by $\sin^2\_$ method.
Examples of concrete applications from a professional experience achieved in an industrial laboratory.

Mr. D. Thiaudière's intervention
Introduction to synchrotron radiation and its properties.
Review about synchrotron sources, methods and developments.

Bibliography :
- C. ESNOUF, Caractérisation microstructurale des matériaux, Presses polytechniques et universitaires romandes (2011)
- L.V. AZAROF, Elements of X-Ray Crystallography, McGraw-Hill Book Company, New-York, London (1968)
- H.P. KLUG, L.E. ALEXANDER, X-Ray Diffraction Procedures, J. Wiley and Sons Inc., New-York, London (1967,1974), ISBN 0.471.49369.4
- A. TAYLOR, X-Ray Metallography, J. Wiley and Sons Inc., New-York, London (1961)
- A. GUINIER, Théorie et Technique de la Radiocristallographie, Dunod, Paris (1964)
- J.P. EBERHART, Analyse structurale et chimique des matériaux, Dunod, Paris (1997), ISBN 2.10.003367.0
- J. PROTAS, Diffraction des Rayonnements : Introduction aux concepts et méthodes, Dunod, Paris (1999), ISBN 2.10.004144.4
- http://escher.epfl.ch/eCrystallography/

Requirements :
Basic concepts of crystal symmetry related to the course entitled "cristallography".

Organisation :

Evaluation :
2 hours exam in classroom

Target :

Mechanics and forming of materials	GPM07-MECA
Number of hours : 32.00 h	3.50 ECTS credit
CM : 24.00 h, TD : 8.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
To understand the mechanical behaviour of metals and their forming using their structural characterization.

Content :
1. Structural defects in metals.
2. Mechanisms of deformation.
3. Elasticity, plasticity.
4. Relationships between structural characterization and mechanical properties.
5. Metals forming processes

Bibliography :
J. Philibert, A. Vignes, Y. Bréchet, P. Combrade, Métallurgie - du minerai au métal, Masson, Paris, 1997, ISBN 2.225.82978.01.
J. Barralis, G. Maeder, Précis de Métallurgie, Nathan, Paris, 1997, ISBN. 2.12.260121.6.

, , , Traité des matériaux, numéro 20 : Sélection des matériaux et des procédés de mise en œuvre, Presses Polytechniques et Universitaires Romandes, 2001, ISBN-10: 2880744733.
M. Colombié, Matériaux métalliques : Propriétés, mise en forme et applications industrielles des métaux et alliages (2e éd.), Dunod, Usine-Nouvelle, 2012, ISBN : 978-2-10-057965-5.

Requirements :
Structural metallurgy.

Organisation :
20 hrs

Evaluation :
2 h examination.

Target :

LABORATORY : MATERIALS 1	GPM07-TPMA
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	hand-out in English and course taught in English
Reference Teacher(s) : THIBON Isabelle	

Objectives :
This course is composed of 4 practical works to help students apprehend thermal treatments and the characterization of materials.

Content :
The topics are:
Metallography I: samples preparation (mechanical polishing, electropolishing, chemical polishing) and optical observation (phase identification for classical microstructures).
Metallography II: optical observation of various microstructures: eutectic, pertectic, montectic.
Thermal analysis: study of a phase diagram through simple thermal analysis, and phase transformation with the help of differential thermal analysis (DTA). Thermodynamical calculus of a phase diagram.
Age hardening of an aluminium alloy (hardness measurement and tensile experiment).

Bibliography :
- A. DE SY, J. VIDTS, Traité de métallurgie structurale théorique et appliquée, Dunod, Paris (1968). - L. HABRAKEN, J.L. DE BROUWER, De Ferri Metallographia I, Fundamentals of Metallography, Presses Académiques Européennes, Bruxelles (1968) _- A. SCHRADER, A. ROSE, De Ferri Metallographia II, Structures of Steels, Verlag Stahleisen m.b.H., Düsseldorf (1966) _- R.F. MEHL, Atlas of Microstructures of Industrial Alloys, Metals Handbook, vol.7, A.S.M. (1972)_- J. PHILIBERT, A. VIGNES, Y. BRECHET, P. COMBRADE, Métallurgie du minerai au matériau, Masson, Paris (1997) ISBN 2.225.82978.0 _- A. TAYLOR, X-Ray Metallography, J. Wiley and Sons Inc., New-York, London (1961)

Requirements :
Knowledge of phase diagrams and thermodynamics of materials.
ESM05-MAT – Materials_SGM06-TH - Thermodynamics of Materials

Organisation :
4h per week.

Evaluation :
1 report for each topic.

Target :

LABORATORY : MATERIALS 1 - RI	GPM07-TPMA RI
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	hand-out in English and course taught in English
Reference Teacher(s) :	

Objectives :
This course is composed of 4 practical works to help students apprehend thermal treatments and the characterization of materials.

Content :
The topics are:
Metallography I: samples preparation (mechanical polishing, electropolishing, chemical polishing) and optical observation (phase identification for classical microstructures).
Metallography II: optical observation of various microstructures: eutectic, pertectic, montectic.
Thermal analysis: study of a phase diagram through simple thermal analysis, and phase transformation with the help of differential thermal analysis (DTA). Thermodynamical calculus of a phase diagram.
Age hardening of an aluminium alloy (hardness measurement and tensile experiment).

Bibliography :
- A. DE SY, J. VIDTS, TraitÝ de mÝtallurgie structurale thÝorique et appliquÝe, Dunod, Paris (1968). - L. HABRAKEN, J.L. DE BROUWER, De Ferri Metallographia I, Fundamentals of Metallography, Presses AcadÝmiques EuropÝennes, Bruxelles (1968) _- A. SCHRADER, A. ROSE, De Ferri Metallographia II, Structures of Steels, Verlag Stahleisen m.b.H., Dösseldorf (1966) _- R.F. MEHL, Atlas of Microstructures of Industrial Alloys, Metals Handbook, vol.7, A.S.M. (1972)_- J. PHILIBERT, A. VIGNES, Y. BRECHET, P. COMBRADE, MÝtallurgie du minerai au matÝriau, Masson, Paris (1997) ISBN 2.225.82978.0 _- A. TAYLOR, X-Ray Metallography, J. Wiley and Sons Inc., New-York, London (1961)

Requirements :
Knowledge of phase diagrams and thermodynamics of materials.
ESM05-MAT ± Materials_SGM06-TH - Thermodynamics of Materials

Organisation :
4h per week.

Evaluation :
1 report for each topic.
A bibliographic report on one scientific article about each practical will be done

Target :

ELECTRONIC FUNCTIONS	GPM07-ELEC
Number of hours : 63.00 h	4.00 ECTS credit
CM : 12.00 h, PR : 16.00 h, TA : 9.00 h, TD : 14.00 h, TP : 12.00 h	
Reference Teacher(s) : BOYER Soline	

Objectives :
From a basic knowledge of the operation of electronic components developed during 3SGM year, the objective of this course is the study of analog electronic functions for measurement and signal transmission.
First part: analog electronic functions for signal generation and transmission: study of oscillators, phase locked loop and classic systems for signal modulation
Second part: Project (group of 4 students, 8 weeks): This project aims at the complete development of an analog electronics setup functions for measurement (Spectrum analyzer, quartz balance, lock-in amplifier) or signal transmission (Frequency synthesizer, amplitude or frequency demodulator)

Content :
Lecture1: Signal and spectrum analysis (reminder of different kind of electrical signal, Fourier transform, limitations of fast and discrete Fourier transform)
Lesson 2: sine wave oscillators (study of the oscillation conditions, high and low frequency circuits, study of nonlinear amplitude stability. Modeling of nonlinearities. Frequency and amplitude stability. Quartz oscillator).
Lesson 3: Amplitude modulation and demodulation: spectrum, modulation circuitry and demodulation. Applications: synchronous detection, spectrum analyzer.
Lesson 4: phase locked loop: principle, phase comparator and voltage controlled oscillator, linear modeling, and applications.
Lesson 5: From Quartz to atomic clock
TP1: Bipolar transistor oscillator: differential amplifier, selective filter, sine wave oscillator.
TP2: Voltage controlled oscillator.
TP3: Phase Locked Loop (PLL)
TP4: Amplitude modulation
Project topics:
Spectrum analyzer, quartz balance, lock-in amplifier, Frequency synthesizer, amplitude demodulator, frequency demodulator

Bibliography :
1. Christophe More, Transmission de signaux, Tec & Doc
2. Microelectronic circuits. A.D. SEDRA and K.C. SMITH, Saunders Collège Publishing.
3. Electronic principles, A.P. Malvino, D.J. Bates, Dunod

Requirements :
3SGM "Electronic circuits" module.

Organisation :
Theory and exercises during 6 weeks (2 hours per week)
3 hours per week practical work or project

Evaluation :
Two-hour written exam.
Mark for Practical Work: one third - continuous appraisal (reports done in pairs); two thirds: project evaluation (demonstration, report, oral defense)

Target :

Semiconductor devices	GPM07-DISP
Number of hours : 32.00 h	3.50 ECTS credit
CM : 18.00 h, TD : 14.00 h	
Reference Teacher(s) : FOLLIOT Herve	

Objectives :
Basics of the operational principle of electronic devices.

Content :
Lesson 1: Semiconductor physics (Reminder), transport phenomena in semiconductors.
Lesson 2: PN junction diodes.
Lesson 3: the bipolar transistor (NPN, PNP, Ebers-Moll equations, high frequency properties).
Lesson 4: the metal-semiconductor diode (Schottky diode).
Lesson 5: Metal-Insulator-Semiconductor structures, charge transfer devices (CCD).
Lesson 6: MOSFET devices.

Bibliography :
- H. Mathieu, Physique des semiconducteurs et des composants électroniques. Masson 1997.
- S.M.Sze, Physics of semiconductor Devices. 2nd Ed. A. Willey. Intersci. Publ. 1981.
- Donald A. Neamen, Semiconductor Physics And Devices, 3rd Ed, Mcgraw Hill 2003.

Requirements :
Basics of semiconductor and junction physics.

Organisation :
A homework of one to two hours per lesson hour is requested.

Evaluation :
Grading is based on continuous assessment (1/3rd) and final assessment (2h written exam, 2/3rd of the grade). The continuous assessment grade itself is based on a 1h written exam and a personal work in the course of the semester.

Target :

Electronic and opto.properties of Solid - based devices	GPM07-TPPED
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
Reference Teacher(s) : BERTRU Nicolas	

Objectives :
Familiarisation with research laboratory conditions over several long-duration practical sessions: set up experiments on a given
subject, gather the necessary data, process and utilise the results and write a report.

Content :
Themes:
- Electronic Paramagnetic Resonance, Ferromagnetic Resonance.
- Ferroelectric behaviour.
- Heterojunctions.
- Optical absorption of Quantum Wells.

Bibliography :
- Practical work lecture notes (1er semester).
- H. MATHIEU, Physique des semiconducteurs et des composants électroniques, Masson (2007).
- S.M. SZE, Physics of Semiconductor Devices, Wiley-Interscience (2006).
- M. BROUSSEAU, Physique du Solide : propriétés électroniques, Dunod (1997).
- C. KITTEL, J. DION, M. GICQUEL, B. VILQUIN, Physique de l'état solide : cours et problèmes, Dunod (2007).

Requirements :
Solid-state physics.
Basic physics of semiconductors and junctions.
Quantum Mechanics.

Organisation :
Preparation before each session: 1 to 2 hours.

Evaluation :
Final mark is based on:
- Work achieved.
- Enthusiasm and initiative.
- Quality of the report.

Target :

Electronic and opto.properties of Solid - based devices - RI	GPM07-TPPED RI
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
Reference Teacher(s) :	

Objectives :
Familiarisation with research laboratory conditions over several long-duration practical sessions: set up experiments on a given
subject, gather the necessary data, process and utilise the results and write a report.

Content :
Themes:
- Electronic Paramagnetic Resonance, Ferromagnetic Resonance.
- Ferroelectric behaviour.
- Heterojunctions.
- Optical absorption of Quantum Wells.

Bibliography :
- Practical work lecture notes (1er semester).
- H. MATHIEU, Physique des semiconducteurs et des composants Ýlectroniques, Masson (2007).
- S.M. SZE, Physics of Semiconductor Devices, Wiley-Interscience (2006).
- M. BROUSSEAU, Physique du Solide : propriÝtÝs Ýlectroniques, Dunod (1997).
- C. KITTEL, J. DION, M. GICQUEL, B. VILQUIN, Physique de l'Ýtat solide : cours et problÜmes, Dunod (2007).

Requirements :
Solid-state physics.
Basic physics of semiconductors and junctions.
Quantum Mechanics.

Organisation :
Preparation before each session: 1 to 2 hours.

Evaluation :
Final mark is based on:
- Work achieved.
- Enthusiasm and initiative.
- Quality of the report.

A bibliographic report on one scientific article about each practical will be done

Target :

Modelling	GPM07-MOD
Number of hours : 14.00 h	2.00 ECTS credit
CM : 2.00 h, TP : 12.00 h	
Reference Teacher(s) : PEDESSEAU Laurent	

Objectives :
- The basic pedagogical support is aimed for the understanding of the finite element (FE) method used through different code largely spread in industry such as Comsol, Silvaco and Catia (Cao).
- Assimilate the basic concepts of F.E. to acquire skills on F.E. codes.
- Use the F.E. method to solve different problems in material sciences, solid states, fluid mechanics, quantum mechanics, heat flux, electromagnetic, semiconductor, polymer.

Content :
Introduction, Generalities, Variational principle, introduction to nonlinear problem.

Bibliography :
- K.J. Bathe : Finite Element Procedures in Engineering Analysis. Prentice et Hall.
- Larson, Mats G., Bengzon, Fredrik: The Finite Element Method: Theory, Implementation, and Applications. Springer
- Zienkiewicz : La Méthode des Eléments Finis. Edisciences.
- Gallagher : Introduction au calcul par Eléments Finis. Editions Pluralis.
- Reddy : An Introduction to finite element method Mac Graw Hill.

Requirements :
Algebra, Matrix calculation, numerical analysis, simulation, material sciences, metallurgy, semiconductor, electromagnetism, heat transfer, fluid mechanic, quantum mechanics

Organisation :
30 hours of personal time

Evaluation :
Proceeding of the training in S7.

Target :

Design of experiments methodology	GPM07-PLAN
Number of hours : 12.00 h	1.50 ECTS credit
CM : 6.00 h, TD : 6.00 h	
Reference Teacher(s) : LEGUESDRON Abdelly	

Objectives :
The aim of the course is to make students aware of industrial system experimentation problems. The chosen approach is the designing of experiments. We introduce a methodology which permits both conception and analysis of such designs. A design of the experiments proposed, for a particular system, a sequence of trials to study the obtained outputs. This method is based on the use of two complementary tools : an algebriac tool to study factors and their interactions and a statistic tool to take into account the natural variability. The course is illustrated with examples and case studies which mainly come from the industry.

Content :
Contents:
- Introduction to design of experiments;
- Design of experiments modeling : algebraic and statistic tool presentation;
- Making use of the design of experiments : from conception to the result analysis;
- Case studies.

Bibliography :
- Stephen R. Schmidt, Robert G. Launsby. Understanding Industrial Designed Experiments. Air Academy Press, 1992.
- J.-J Droesbeke, J. Fine, G. Saporta. Plans d'expériences : Applications à l'entreprise. Editions Technip, 1997.

Requirements :
Mathematical backgrounds of undergraduate studies and statistic inference.

Organisation :

Evaluation :
A 1-hour test is scheduled at the end of the semester.

Target :

Conferences	GPM07-CONF
Number of hours : 12.00 h	0.50 ECTS credit
CONF : 12.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
Professionals from a wide range of companies hold conferences on the various career options open to students in the MNT
department. The guest speakers describe their companies' engineering work and market structure. The aim is to help students in
their choice of career.

Content :
Career guidance through conferences.

Bibliography :

Requirements :

Organisation :

Evaluation :
Signed attendance sheets.

Target :

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

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

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

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

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

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

Evaluation :
One two-hour written exam.

Target :

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

Objectives :
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 :

INNOVATION & ENTREPRENEURSHIP (RIE)	HUM07-IE
Number of hours : 54.00 h	3.00 ECTS credit
TD : 54.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

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

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

Requirements :

Organisation :

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

Target :

Initiation à la recherche	GPM07-RI
Number of hours : 30.00 h	1.50 ECTS credit
PR : 30.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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 Formation Initiale GPM

1	**GPM08-1**		**Materials Science 2**	**4.00**
	GPM08-DIFF	O	Diffusion in Solids	1.50
	GPM08-TCM	O	Techniques de caractérisation des matériaux	1.00
	GPM08-TPMA	C	LABORATORY : MATERIALS 2	1.50
	GPM08-TPMA RI	C	LABORATORY : MATERIALS 2 – RI	1.50
2	**GPM08-2**		**Electronic Devices Technology 2**	**6.50**
	GPM08-TCSI	O	Silicon Devices Technology	1.50
	GPM08-TPSB1	C	CCMO Clean room experimental work	1.00
	GPM08-TPSB2	C	TOP35 Clean room experimental work	1.00
	GPM08-POM	O	Optical Properties of Materials	2.50
	GPM08-TPPED	C	Electronic and Opto. Properties of Solid-Based Devices	1.50
	GPM08-TPPED RI	C	Electronic and Opto. Properties of Solid-Based Devices – RI	1.50
3	**GPM08-3**		**Electronic & Measurement 2**	**5.50**
	GPM08-PSM	O	Material simulation project	2.50
	GPM08-LAB	C	LABVIEW CORE 2	2.50
	GPM08-LAB RI	C	LabVIEW Fondamental 2 - RI	2.50
	GPM08-CONF	O	Conferences	0.50
4	**GPM08-4**		**STAGE S8**	**8.00**
	GPM08-STA4	O	4th year Work Placement	8.00
5	**HUM08**		**Non-scientific syllabus S8**	**6.00**
	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
6	**GPMF2-RI**		**Parcours RI S8**	**1.50**
	GPM08-RI	F	Initiation à la recherche	1.50

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

Diffusion in Solids	GPM08-DIFF
Number of hours : 20.00 h	1.50 ECTS credit
CM : 10.00 h, TD : 10.00 h	
Reference Teacher(s) : THIBON Isabelle	

Objectives :
Study of diffusion phenomena in crystallized solids. Mathematical equations for diffusion Identification of the different diffusion coefficients. Solutions od the diffusion equation for problems in materials science (metallurgy, semiconductors).

Content :
Fick's law - Diffusion equations - Solving simple problems - Boltzmann-Matano method
Diffusion mechanisms - Arrhenius' law
Diffusion in poly-phase systems - Example: metal oxidation.
Interdiffusion and the Kirkendall effect.
Diffusion short-circuits - Grain boundary diffusion.

Bibliography :
J. PHILIBERT, Diffusion et transport de matière dans les solides, Ed. de Physique (1985)
M. GLICKSMAN, Diffusion in solids, John Wiley et Sons ed. (2000)
J. CRANK, The Mathematics of diffusion, Oxford University Press (1980)

Requirements :
Knowledge in basic materials science, thermodynamics of materials, crystallography.
ESM05-MAT – Materials_SGM06-TH – Thermodynamics Materials_SGM07-CRIS - Crystallography

Organisation :
4h per week

Evaluation :
2 h written examination.

Target :

Techniques de caractérisation des matériaux	GPM08-TCM
Number of hours : 18.00 h	1.00 ECTS credit
CM : 12.00 h, TP : 6.00 h	
Reference Teacher(s) : CASTANY Philippe	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

LABORATORY : MATERIALS 2	GPM08-TPMA
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	hand-out in English and course taught in English
Reference Teacher(s) : THIBON Isabelle	

Objectives :
This course is composed of 4 practical works of 8h for the students to apprehend thermal treatments and the characterization of materials.

Content :
The topics are:
1. Steel hardenability: Jominy test of 3 steels
2. Gas-solid diffusion: Zirconium oxidation.
3. Crystallography: Laue methods and stereographic projection. Powder method (indexation and calculus of lattice parameter)
4. Crystallography: Structure and calculation of diffraction intensity. Representation of crystallographic structures.

Bibliography :
- A. DE SY, J. VIDTS, Traité de métallurgie structurale théorique et appliquée, Dunod, Paris (1968). - L. HABRAKEN, J.L. DE BROUWER, De Ferri Metallographia I, Fundamentals of Metallography, Presses Académiques Européennes, Bruxelles (1968) _- A. SCHRADER, A. ROSE, De Ferri Metallographia II, Structures of Steels, Verlag Stahleisen m.b.H., Düsseldorf (1966) _- R.F. MEHL, Atlas of Microstructures of Industrial Alloys, Metals Handbook, vol.7, A.S.M. (1972)_- J. PHILIBERT, A. VIGNES, Y. BRECHET, P. COMBRADE, Métallurgie du minerai au matériau, Masson, Paris (1997) ISBN 2.225.82978.0 _- A. TAYLOR, X-Ray Metallography, J. Wiley and Sons Inc., New-York, London (1961)

Requirements :
Knowledge of phase diagrams and thermodynamics of materials.
ESM05-MAT – Materials_SGM06-TH - Thermodynamics of Materials_SGM07-CRIS - CRYSTALLOGRAPHY_SGM07-DRX - Structural Analysis OF MATERIALS BY X-RAY SCATTERING ANd DIFFRACTION

Organisation :
4h per week

Evaluation :
1 report for each topic.

Target :

LABORATORY : MATERIALS 2 – RI	GPM08-TPMA RI
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	hand-out in English and course taught in English
Reference Teacher(s) :	

Objectives :
This course is composed of 4 practical works of 8h for the students to apprehend thermal treatments and the characterization of materials.

Content :
The topics are:
1. Steel hardenability: Jominy test of 3 steels
2. Gas-solid diffusion: Zirconium oxidation.
3. Crystallography: Laue methods and stereographic projection. Powder method (indexation and calculus of lattice parameter)
4. Crystallography: Structure and calculation of diffraction intensity. Representation of crystallographic structures.

Bibliography :
- A. DE SY, J. VIDTS, TraitÝ de mÝtallurgie structurale thÝorique et appliquÝe, Dunod, Paris (1968). - L. HABRAKEN, J.L. DE BROUWER, De Ferri Metallographia I, Fundamentals of Metallography, Presses AcadÝmiques EuropÝennes, Bruxelles (1968) _- A. SCHRADER, A. ROSE, De Ferri Metallographia II, Structures of Steels, Verlag Stahleisen m.b.H., Dösseldorf (1966) _- R.F. MEHL, Atlas of Microstructures of Industrial Alloys, Metals Handbook, vol.7, A.S.M. (1972)_- J. PHILIBERT, A. VIGNES, Y. BRECHET, P. COMBRADE, MÝtallurgie du minerai au matÝriau, Masson, Paris (1997) ISBN 2.225.82978.0 _- A. TAYLOR, X-Ray Metallography, J. Wiley and Sons Inc., New-York, London (1961)

Requirements :
Knowledge of phase diagrams and thermodynamics of materials.
ESM05-MAT ± Materials_SGM06-TH - Thermodynamics of Materials_SGM07-CRIS - CRYSTALLOGRAPHY_SGM07-DRX - Structural Analysis OF MATERIALS BY X-RAY SCATTERING ANd DIFFRACTION

Organisation :
4h per week

Evaluation :
1 report for each topic.
A bibliographic report on one scientific article about each practical will be done

Target :

Silicon Devices Technology	GPM08-TCSI
Number of hours : 20.00 h	1.50 ECTS credit
CM : 20.00 h	
Reference Teacher(s) : CASTANY Philippe	

Objectives :
Basics of Silicon microelectronics. Description of the basic manufacturing processes and the different process technologies.
Study of the quality and reliability aspects of microelectronics. Applications.

Content :
- Description of the different stages of manufacturing from conception to delivery. Integrated quality control.
- Conception flow, foundry operations, assembly and video test flow.
- Bipolar process technology. Assembly of a bipolar process technology with junction insulation, basic elements (npn
transistors, pnp, Schottky, resistors, diodes), advanced bipolar technologies.
- CMOS process technology. Assembling of a CMOS process technology, basic elements (inverters, nand, nor), advanced
CMOS technologies and BiCMOS.
- Quality and reliability of the technologies.
- The manufacturing processes of the customer-provider interface. reliability of the devices, case study.
- Silicon products. Present and future fields of application.
- Predictable evolution of the technology and performance.

Bibliography :
- Solid State Technology (Penwell Publication)
- Semiconductor Technology (Semiconductor Technology)
- Silicon Processing for the VLSI Era Vol. 1 et 2 par Stanley Wolf (Lattice Press)
- CMOS Technology par James A Cunningham (Technology Associates)

Requirements :
Course on Semiconductor devices.
Course on Solid-state physics.
Course on Logics.
Course on Crystallography and Metallurgy.

Organisation :
8 hours approximately.

Evaluation :
Two-hour written examination (documents allowed) at the end of the semester.

Target :

CCMO Clean room experimental work	GPM08-TPSB1
Number of hours : 26.00 h	1.00 ECTS credit
TD : 2.00 h, TP : 24.00 h	
Reference Teacher(s) : LEVALLOIS Christophe	

Objectives :
This practical course is devoted to the fabrication of MOS transistors based on a 4 mask levels process. This course is given in
the IETR clean-room at the University of Rennes1. The main objective is to introduce students to the different technology
steps required for the fabrication of MOS transistors. At the end of the formation the devices fabricated are also characterized
by electrical tests under probes.

Content :
The process starts with an oxidized silicon substrate and the students process themselves all the operations which are required
(photolithography, chemical etching, thermal oxidation, doping by thermal diffusion, metallization) for the transistor MOS
fabrication. At the end of the fabrication, electrical tests are performed on basic devices (diodes, resistances, MOS capacity,
MOS transitor)

Bibliography :
- S.M. SZE, VLSI Technology, Mc Graw Hill (1998)
- C.Y. CHANG and S.M. SZE, ULSI Technology, Mc Graw Hill (1996)
- P.N. FAVENNEC, Technologie pour les composants à semiconducteurs, Dunod (1997)

Requirements :
- course on semiconductors devices.
- course on the technological process of silicon devices

Organisation :
This course required around 2 hours of personal work

Evaluation :
A group of students (mostly 4) has to realize a single manuscript for the evaluation.

Target :

TOP35 Clean room experimental work	GPM08-TPSB2
Number of hours : 21.50 h	1.00 ECTS credit
TD : 2.00 h, TP : 19.50 h	
Reference Teacher(s) : PARANTHOEN Cyril	

Objectives :
TOP35 (III-V semiconductors Optoelectronic based processing) objective is to propose a complete formation dedicated to
optoelectronic devices, through the realization of a photonic device : a laser diode for telecommnunication applications. The
formation spans all the fundamentals necessary for the realization of a device, from the device growth and design, the
clean-room processing, ending with the electro-optical characterizations.

Content :
The 20 hours long practical work (on 2.5 days) deals with :
- device growth and design with molecular beam epitaxy (MBE)(2h + individual work) : basics of MBE, RHEED oscillations
flux calibrations, X-ray diffraction and photoluminescence analysis.
- single transverse mode edge emitting laser processing in clean-room (16 h) : optical photolithography (2 levels), insulating
material deposition with PECVD, dry etching (RIE), electrical contacts deposition with RF sputtering, back-end technologies
(mechanical thinning, cleaving) and controls (optical microscope, profilometer, electrical tests on probe station)
- Electro-optical characterizations of lasers diodes (2 h) : spectral, I(V) and P(I) measurements, efficiencies measurements.

Bibliography :
lecture notes :
- semiconductors and semcondcutors laser diodes basics
- semiconductors laser diodes processing

Requirements :
Basics in quantum mechanics, optoelectronics, device processing.

Organisation :
2 to 3 h per student.

Evaluation :
A group of students (mostly 4) has to realize a single manuscript for the evaluation.

Target :

Optical Properties of Materials	GPM08-POM
Number of hours : 27.00 h	2.50 ECTS credit
CM : 14.00 h, TD : 13.00 h	
Reference Teacher(s) : LE CORRE Alain	

Objectives :
Further basics of physics of solids with focus on polarisation and interaction with radiation. Description of operational
principles, properties and optoelectronic structures using these properties.

Content :
- General properties of dielectrics: polarisation, dielectric constant, polarisability, local electrical field, Clausius Mossoti
relation, Lyddane-Sachs-Teller relation.
- Solids optical properties: Classic approach. Optical constants, Kramers- Kronig relations, classical theory of dispersion in an
isotropic solid in a linear response situation for dielectrics, conductors and ionic crystals. Application to metals and semiconductors.
- Matter-radiation interaction: consequences of the quantification. Black body radiation: Plank's law. Einstein's emission and
absorption constants, detailed balance.
- Application of stimulated emission: laser effect.

Bibliography :
- Physique du Solides et Propriétés électroniques, M. BROUSSEAU, Masson 1992,
- Physique des semi-conducteurs et des composants électroniques, H. MATHIEU, Masson 1987.
- Initiation à la Physique du Solides, Exercices commentés, J. CAZAUX, Masson 1989.
- Optoelectronics, E Rosencher, B. Vinter, P. G. Priva, Masson 1998, Cambridge University Press, 2002

Requirements :
Basics of Quantum Mechanics.

Organisation :
3 hours per week minimum.

Evaluation :

Target :

Electronic and Opto. Properties of Solid-Based Devices	GPM08-TPPED
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
Reference Teacher(s) : BERTRU Nicolas	

Objectives :
Familiarisation with research laboratory conditions over several long-duration practical sessions. Setting up experiments on a
given subject, gathering the necessary data, processing and utilising the results, writing a report.

Content :
Topics:
- MIS structure.
- Optical cavity and distributed Bragg reflectors.
- Er doped fibre optical amplifier, lasers (Er doped fiber lasers, semiconductor lasers).
- NMOS device simulation.

Bibliography :
- Practical work lecture notes (2nd semester)
- E.H. NICOLLIAN and J.R. BREWS, MOS Physics and Technology, Wiley-Interscience (2002)
- H. MATHIEU, Physique des semiconducteurs et des composants électroniques, Masson (2007)
- S.M. SZE, Physics of Semiconductor Devices, Wiley-Interscience (2006)
- E. ROSENCHER et J. VINTER, Optoélectronique : cours et exercices corrigés, Dunod (2002)
- S. M. SZE, Very Large Scale Integration Technology, Mc Graw Hill (1998)

Requirements :
Modules on Electronic and optoelectronic devices and the technology of components.

Organisation :
This module requires approximately 1-2 hours of personal work for each session

Evaluation :
Final mark is based on:
- Work achieved.
- The student's personal interest and initiative.
- Quality of the reports.

Target :

Electronic and Opto. Properties of Solid-Based Devices – RI	GPM08-TPPED RI
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
Reference Teacher(s) :	

Objectives :
Familiarisation with research laboratory conditions over several long-duration practical sessions. Setting up experiments on a
given subject, gathering the necessary data, processing and utilising the results, writing a report.

Content :
Topics:
- MIS structure.
- Optical cavity and distributed Bragg reflectors.
- Er doped fibre optical amplifier, lasers (Er doped fiber lasers, semiconductor lasers).
- NMOS device simulation.

Bibliography :
- Practical work lecture notes (2nd semester)
- E.H. NICOLLIAN and J.R. BREWS, MOS Physics and Technology, Wiley-Interscience (2002)
- H. MATHIEU, Physique des semiconducteurs et des composants Ýlectroniques, Masson (2007)
- S.M. SZE, Physics of Semiconductor Devices, Wiley-Interscience (2006)
- E. ROSENCHER et J. VINTER, OptoÝlectronique : cours et exercices corrigÝs, Dunod (2002)
- S. M. SZE, Very Large Scale Integration Technology, Mc Graw Hill (1998)

Requirements :
Modules on Electronic and optoelectronic devices and the technology of components.

Organisation :
This module requires approximately 1-2 hours of personal work for each session.

Evaluation :
Final mark is based on:
- Work achieved.
- The student's personal interest and initiative.
- Quality of the reports.
- A bibliographic report on one scientific article about each practical will be done

Target :

Material simulation project	GPM08-PSM
Number of hours : 36.00 h	2.50 ECTS credit
EP : 12.00 h	
Reference Teacher(s) : PEDESSEAU Laurent	

Objectives :
- Simulation project based on the use of Comsol, Silvaco or Catia.
- Define a simulation study
- Simplify the problem as much as possible
- Model the physical properties
- Analyze the simulation and compare it as possible with realistic measurement
- Increase the accuracy and the level of theory
- Analyze the simulation and compare it as possible with realistic measurement
- Conclude & Perspective

Content :
Learn the basic to be able to simulate material properties via Comsol, Silvaco or Catia.

Bibliography :
- K.J. Bathe : Finite Element Procedures in Engineering Analysis. Prentice et Hall.
- Larson, Mats G., Bengzon, Fredrik: The Finite Element Method: Theory, Implementation, and Applications. Springer
- Zienkiewicz : La Méthode des Eléments Finis. Edisciences.
- Gallagher : Introduction au calcul par Eléments Finis. Editions Pluralis.
- Reddy : An Introduction to finite element method Mac Graw Hill.

Requirements :
Algebra, Matrix calculation, numerical analysis, simulation, material sciences, metallurgy, semiconductor, electromagnetism, heat transfer, fluid mechanic, quantum mechanics

Organisation :
30 hours of personal time

Evaluation :
Supervisor's assessment - handed in with the report on final project. Proceeding/Report of simulation project in S8 written either in English or in French. Final evaluation will be given in terms of a mark scaled from 0 to 20.

Target :

LABVIEW CORE 2	GPM08-LAB
Number of hours : 32.00 h	2.50 ECTS credit
EP : 0.00 h, PR : 23.00 h, TD : 0.00 h, TP : 9.00 h	
Reference Teacher(s) : PERRIN Mathieu	

Objectives :
The LabVIEW Core 2 course is an extension of the LabVIEW Core 1 course studied during the third year and teaches you to use common design patterns to successfully implement and distribute LabVIEW applications for research, engineering, and testing environments. Topics covered include programmatic control of your user interface, techniques to optimize reuse of existing code, use of file I/O functions, and tools to create executables and installers. This course directly links LabVIEW functionality to your application needs and provides a jump-start for application development.
Mini-projects allow you to put what you have learned into practice. To have more ambitious projects, part of the code made during year n may be given as input for you to improve on year n+1. A good team work will be necessary as you will work by groups of 4 students in a limited amount of time. The course can be proposed through distance learning for mobility students by removing the mini-project part.

Content :
After a review exercise on the LabVIEW Core 1 course included in the 3rd year Instrumentation and Measurement course, the following lessons will be developed during 4 lab work based courses.

LAB 1. Using Variables (lesson 1)
- Communicating between parallel loops;
- Using local and global variables;
- Writing to controls and reading from indicators;
- Understanding and avoiding race conditions.

LAB 1. Communicating Data Between Parallel Loops (lesson 2)
- Using queues to pass buffered data between loops;
- Using notifiers to broadcast data to multiple loops.

LAB 2. Implementing Design Patterns (lesson 3)
- Using single loop design patterns– Including the state machine design patterns and functional global variables;
- Using multiple loop design patterns–Including producer/consumer design patterns;
- Handling errors;
- Generating error codes and messages;
- Timing a design pattern.

LAB 3. Controlling the User Interface (lesson 4)
- VI Server architecture;
- Using property nodes;
- Using invoke nodes;
- Creating and using control references.

LAB 3. Creating and Distributing Applications (lesson 7)
- Preparing the files;
- Creating build specifications;
- Creating and debugging an application;
- Creating an Installer.

LAB 4. File I/O Techniques (lesson 5)
- Comparing file formats;
- Creating file and folder paths;
- Writing and reading binary files;
- Working with multichannel text files with headers;
- Accessing Technical data management streaming (TDMS) files in LabVIEW and Excel.

LAB 4. Improving an Existing VI (lesson 6)
- Refactoring inherited code;
- Typical issues when refactoring code.

Bibliography :

Requirements :
To efficiently follow the LabVIEW Core 2 course, it is necessary to have taken a course equivalent to LabVIEW Core 1 such as the Instrumentation and Measurement course in 3SGM.

Organisation :
Organisation, méthodes pédagogiques
The course is divided into four 3 hours-long lab work sessions. To optimize the time in the computer room, the course is taught in flipped classroom, meaning that the multimedia modules and slides must be seen before the class, which will start straight with the exercises.
Projects begin with a general presentation of hardware and of the requirement specifications to meet. To complete the project, you will have three 3-hours-long sessions with your instructor and three others in full autonomy. You can additionally enter the room outside class hours by asking the technicians to open the room for you.

Evaluation :
The class objective is to get the CLAD certification (Certified LabVIEW Associate Developper). A CLAD session will be organized and observed at INSA by National Instruments. Mobility students following the class through distance learning are bound to register to the CLAD in a Pearson Vue center near their mobility location, and to allow National Instruments to communicate the results back to INSA as, for these students, the CLAD will be the only grading of the course. CLAD results, over 100, will be directly converted into a grade over 20. The CLAD certification requires at least a score of 70/100, or 14/20, while the course will be considered valid with usual INSA rules (10/20).
As the CLAD test is on both LabVIEW Core 1 and LabVIEW Core 2 courses, a 1-hour Multiple Choice Exam will be organized internally. The best of the two grades (CLAD or home-made Multiple choice) will be retained and constitute the Exam grade.
Mini-projects will be graded on the basis of a mid-term report and a final report, as well as the produced code. This evaluation will give the Lab-work grade. The course final grade will be the average between the Exam and the Lab-work grade.

Target :

LabVIEW Fondamental 2 - RI	GPM08-LAB RI
Number of hours : 33.00 h	2.50 ECTS credit
EP : 9.00 h, PR : 9.00 h, TD : 3.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Conferences	GPM08-CONF
Number of hours : 15.00 h	0.50 ECTS credit
CONF : 15.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
Professionals from a wide range of companies hold conferences on the various career options open to students in the MNT
department. The guest speakers describe their companies' engineering work and market structure. The aim is to help students in
their choice of career. The validation of the module gives 1 ECTS credit.

Content :
Career guidance through conferences.

Bibliography :

Requirements :

Organisation :

Evaluation :
Validation system:
Signed attendance sheets.

Target :

4th year Work Placement	GPM08-STA4
Number of hours : 255.00 h	8.00 ECTS credit
DIV : 15.00 h, ST : 240.00 h	
Reference Teacher(s) : JANCU Jean-Marc, LEVALLOIS Christophe	

Objectives :
This fourth year placement constitutes a minimum of eight weeks in a company or in a research laboratory. It must take place
between the end of the fourth year and the beginning of the fifth year and must enable the student to put into practice the
knowledge acquired on the course. Finding the placement and the placement itself will prepare the student for job seeking.
Each proposal must be approved by the person in charge of work placements and the Director of the department. The former
validates the placement (8 ECTS credits).

Content :
Finding a suitable placement is up to the student's own initiative: establishing contacts, job interviews, ect.
Length of the placement: 8 weeks minimum.
Period: from the beginning of June onwards.

Bibliography :

Requirements :
Level corresponding to three semesters of training on the course.

Organisation :
Full-time work in the host establishment.

Evaluation :
Supervisor's assessment - handed in with the report on final project.
Report on the fourth year placement written either in English or in French.
Poster
Oral presentation before a jury composed of 2 teachers from the MNT department.
Final evaluation will be given in terms of a mark scaled from 0 to 20.

Target :

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

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

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

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

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

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

Evaluation :
TOEIC
15 minute oral exam

Target :

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

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 :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

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

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

Requirements :

Organisation :

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

Target :

INNOVATION & ENTREPRENEURSHIP (RIE)	HUM08-IE
Number of hours : 48.00 h	2.00 ECTS credit
TD : 48.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Initiation à la recherche	GPM08-RI
Number of hours : 30.00 h	1.50 ECTS credit
TD : 30.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 9

Parcours Contrat Professionnel

1	**GPM09-1 PRO**		**SCIENCE DES MATERIAUX S9 CPro**	**9.50**
	GPM09-MIMA	O	Microstructures of Materials	2.50
	GPM09-MECA	O	MECHANICS OF MATERIALS	1.00
	GPM09-BIO	O	Biomaterials	1.50
	GPM09-MACC	O	Materials : selection and conception	1.50
	GPM09-PRO SCND	O	Ingénierie des Assemblages : Soudage et Controles Non Destructifs	1.50
	GPM09-CIMA	O	Case Studies Materials	1.50
2	**GPM09-2 PRO MO**		**MICRO ET OPTOELECTRONIQUE S9 CPro**	**10.00**
	GPM09-PRO-ENER	O	Energies Renouvelables	2.50
	GPM09-NANO	O	Carbon Nanotubes	1.00
	GPM09-BPMS	O	Biomaterials, biochips and microsystems	1.00
	GPM09-OPTO	O	Optoelectronics 2	2.50
	GPM09-ONL	O	Nonlinear Optics	1.50
	GPM09-CIMO	O	Case Studies Optoelectronics	1.50
3	**GPM09-3**		**Enseignement scientifiques à choix S9**	**2.00**
	GPM09-MAVA	C	Advanced Materials Science	2.00
	GPM09-SAP	C	Searching and analysing patents	2.00
4	**GPM09-4**		**Projets**	**3.00**
	GPM09-PI	C	INDUSTRIAL PROJECTS	3.00
	GPM09-POR	C	Projet Orienté Recherche	3.00
5	**HUM09-GPM-PRO**		**ENSEIGNEMENTS D'HUMANITE S9 CPro**	**5.50**
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-PM-PRO	O	Economics, Law and Business Studies (Professional management)	2.00
	GPM09-CONF	O	Conférences	0.50
7	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00
8	**GPM09-1**		**Emerging technologies**	**10.00**
	GPM09-MIMA	O	Microstructures of Materials	2.50
	GPM09-MECA	O	MECHANICS OF MATERIALS	1.00
	GPM09-BIO	O	Biomaterials	1.50
	GPM09-MACC	O	Materials : selection and conception	1.50
	GPM09-SCND	O	ASSEMBLIES ENGINEERING : WELDING AND NON DESTRUCTIVE TESTING	2.00
	GPM09-CIMA	O	Case Studies Materials	1.50
9	**GPM09-2**		**Materials Science 4**	**9.50**
	GPM09-ENER	O	Renewable Energy	2.00
	GPM09-NANO	O	Carbon Nanotubes	1.00
	GPM09-BPMS	O	Biomaterials, biochips and microsystems	1.00
	GPM09-OPTO	O	Optoelectronics 2	2.50
	GPM09-ONL	O	Nonlinear Optics	1.50
	GPM09-CIMO	O	Case Studies Optoelectronics	1.50

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

Microstructures of Materials	GPM09-MIMA
Number of hours : 20.00 h	2.50 ECTS credit
CM : 18.00 h, TP : 0.00 h	
Reference Teacher(s) : GLORIANT Thierry, THIBON Isabelle	

Objectives :
Introduction to thermodynamics and phase transformation in polycrystalline solids.

Content :
General aspects of thermodynamics and phase transformation. Germination and growth mechanisms. Surfaces and interfaces in
crystalline solids. Interphases and grain boundaries: notion of coherence.
Texture and anisotropy in polycrystalline materials. Recovery and recrystallisation.

Bibliography :
J.W. MARTIN, R.D. DOHERTY, Stability of microstructure in metallic systems, Cambridge University Press, London,1976 , ISBN 0.521.20875.0.
D.A. PORTER, K.E.EASTERLING, Phase transformations in metals and alloys, Taylor et Francis Group, 2004, ISBN
0.7487.5741.4.
V.RANDLE, O.ENGLER, Introduction to texture analysis : macrotexture, microtexture and orientation mapping, Gordon and Breach ed., 2000.
F.J.HUMPHREYS, M.HATHERLY, Recrystallization and Related Annealing Phenomena, Pergamon ed., 2004.

Requirements :
Fundamental knowledge of Structural Metallurgy and Crystallography.

Organisation :
Sixty to ninety minutes per week.

Evaluation :
Two-hour written examination.

Target :

MECHANICS OF MATERIALS	GPM09-MECA
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
Study of mechanical properties of materials in correlation with their microstructure.

Content :
1. Physical mechanisms of the mechanical behavior of materials.
2. Constitutive laws of elasto-plasticity.
3. Microscopic plasticity.
4. Macroscopic plasticity.

Bibliography :
- J. PHILIBERT, A. VIGNES, Y. BRECHET, COMBRADE, "" Métallurgie du minerai au matériau "", Masson, 1998
- D. FRANCOIS, A. PINEAU, A. ZAOUI, "" Comportement mécanique des matériaux "", Tome1, Hermes, 1991

Requirements :
Materials science, general mechanics, mechanics of solids.

Organisation :
9 hours.

Evaluation :
1 h examination.

Target :

Biomaterials	GPM09-BIO
Number of hours : 16.00 h	1.50 ECTS credit
CM : 16.00 h, CONF : 0.00 h	
Reference Teacher(s) : GORDIN Doina-Margareta	

Objectives :
To acquire basic notions on biomaterials: properties, synthesis, biomaterials-human body interactions, biomedical applications.

Content :
- Classifications (biocompatibility, biomaterials);
- Natural Biomaterials;
- Metallic Biomaterials;
- Bioceramics;
- Biopolymers;
- Biocomposites;
- Process Synthesis
- Properties: physical, chemical, mechanical, biocompatibility etc;
- Biomaterials-cells, biomaterials-tissues, biomaterials-body fluids;
- Biomechanics: basic notions;
- Biomedical applications.

Bibliography :
Biomaterials Science (Third Edition) An Introduction to Materials in Medicine
Edited by: Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons _ISBN: 978-0-12-374626-9
Introduction to Biomaterials: Basic Theory with Engineering Applications (Cambridge Texts in Biomedical Engineering) 1st Edition, 2013, by , , , ISBN: 978-0521116909.
Essential Biomaterials Science (Cambridge Texts in Biomedical Engineering), 1st Edition, 2014 by , ISBN: 978-0521899086

Requirements :
-Basic Knowledge on Materials (metal, ceramics, polymers, composites);
-Basic Notions in Mechanics, Electrochemistry.

Organisation :
Course 1 hour per week

Evaluation :
1 written examination (1h)

Target :

Materials : selection and conception	GPM09-MACC
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h, TD : 0.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
Selection of the best materials for a given application.

Content :
1.Types of materials.
2.Physical and mechanical parameters for the study of Ashby diagrams.
3.Presentation of a software to select materials.
4.Introduction to Computer-Aid Design (CAD).
5.Use of the CATIA software, examples of application.
6.Fundamental equations of the mechanics of solids.
7.Resolution of problems of mechanics in linear elasticity.

Bibliography :
Michael F. Ashby, David R.H. Jones, Matériaux, Tome 1, Propriétés et applications, Dunod, 1998.
Michael F. Ashby, David R.H. Jones, Matériaux, Tome 2, Microstructure et mise en œuvre, Dunod, 1998.

Requirements :
Metallurgy, general mechanic, Mechanic of solids.

Organisation :
10 h

Evaluation :
1 h examination.

Target :

Ingénierie des Assemblages : Soudage et Controles Non Destructifs	GPM09-PRO SCND
Number of hours : 28.00 h	1.50 ECTS credit
CM : 20.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Case Studies Materials	GPM09-CIMA
Number of hours : 27.00 h	1.50 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
These courses offer a chance to open the last year training to the world of business by integrating lectures given by engineers coming from different companies.
Apply the teaching to industrial problems.

Content :
Every year the content can change, depending on the engineers accepting to give lessons.

Bibliography :

Requirements :
3GPM et 4GPM training

Organisation :

Evaluation :
Based on the presence, no written exam.

Target :
Public
5GPM students

Energies Renouvelables	GPM09-PRO-ENER
Number of hours : 15.00 h	2.50 ECTS credit
CM : 9.00 h, CONF : 6.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Carbon Nanotubes	GPM09-NANO
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : GUEZO Maud	

Objectives :
Properties of carbon nanotubes(structural electronic and optical). Basic methods for the study of nanostructured materials using
X-ray and neutron scattering.

Content :
CARBON NANOTUBES (M. Gicquel):
I. Introduction to the C element (diamond, graphite, nanotubes (NT), fullerene)
II. History of carbon NT (CNT), since 1991(date of discovery).
III. Fabrication techniques for CNT.
IV. Structural properties of CNT.
V. Optical properties of CNT : linear and non linear(absorption, PL, PLE) (pump probe measurements).
VI. Recent and future applications : nanoelectronics, NEMS, fibres, biomedical...
VII. Other NT : BN, SIC, Si.

Bibliography :
A Carbon nanotubes
- "Carbon nanotubes and related structures", Peter J.F. Harris.
- "Physical properties of carbon nanotubes", Dresselhaus, Dresselhaus, Saito.
- "Etude des propriétés optiques des nanotubes de carbone", J.-S. Lauret, thèse de doctorat de l'Université Paris VI, Décembre 2003.
- "Physique de l'état solide", Charles Kittel, 8e édition :nouveau chapitre sur les nanostructures (1D et 0D).-
or in English : "Solid state physics", C. Kittel, Wiley 8th edition.

Requirements :
Properties of semiconductors (3rd and 4th years of MNT).
Structural analysis.
Scattering/diffraction and reciprocal space.

Organisation :
One hour for every hour of lecture time.

Evaluation :
One-hour written examination.

Target :

Biomaterials, biochips and microsystems	GPM09-BPMS
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : PIRON Rozenn	

Objectives :
Use of biology and chemistry orientated applications to set up a multi-disciplinary technology for the development of
microsystems. Presentation of the different biomaterials. Presentation of various biomaterials for medical applications.

Content :
General introduction to biochips: DNA chips, protein chips, chip laboratory, cell chips.
Introduction to microfluidics (overview of hydrodynamics, microsystem mixes, surface effects).
Overview of methods for handling and/or separating chemical or biological substances (electrophoresis, dielectrophoresis,
magnetophoresis, optical tweezers).
Short presentation of microfabrication techniques enabling biomicrosystem manufacturing (etching, PDMS technology, soft
lithography, surface functionalisation).
Introduction to biomaterials.
Main categories of biomaterials (natural biomaterials, synthetic biomaterials).
Interaction between biomaterials and a physiological environment.
Biomaterials in medicine.

Bibliography :
Introduction à la microfluidique - Collection Echelles. Par Tabeling, P. Editions Belin (2003).

Requirements :
Basics of physics, materials science, biology and anatomy.

Organisation :
Two - three hours per week.

Evaluation :
One-hour written examination.

Target :

Optoelectronics 2	GPM09-OPTO
Number of hours : 27.00 h	2.50 ECTS credit
CM : 14.00 h, TD : 13.00 h	
Reference Teacher(s) :	

Objectives :
Final part of solid-state physics with focus on the optical properties of semiconductors. Description of the operating principles
of semiconductor optoelectronic devices (photodetectors, lasers and optical amplifiers).

Content :
- Optical properties of semiconductors: quantum mechanics approach, radiation/semiconductor interaction, optical absorption
in a semiconductor, selection rules for optical transitions, absorption coefficient calculation, (direct or indirect gap), density of
state, calculation of the bimolecular coefficient, calculation of the spontaneous emission spectrum.
- Semiconductor radiation detection devices: Various types of detectors, physical quantities. Noise sources, detection limits.
- Photodetection using photoconductors: photoexcitation in a homogeneous semiconductor, photo-carrier distribution, response
of a photoconductor.
- Photodetection using photodiodes: general overview of photodiodes. Photocurrent calculations, PIN photodiode.
- Other semiconductor detection devices: avalanche photodiode, Schottky photodiode, phototransistor. Image detectors or
imagers: CCD matrices, infrared imager. Semiconductor radiation emitting devices.
- Population inversion in an out-of-equilibrium semiconductor: pseudo-Fermi levels, net emission rate, recombination of
excess carriers, radiative and non-radiative lifetime. Semiconductor Light-Emitting Diodes (LED): operational principle, yield,
recombination mechanisms. Typical structures of LEDs.
- Semiconductor lasers. Radiation amplification in a semiconductor. Threshold current. Spectral distribution of the radiation,
modulation, electrical and optical conconfinement, advantages of double heterostructures.
- Evolution of semiconductor laser structures: response time, cut-off frequency, energy distribution of the radiation, spectral
width.

Bibliography :
- Physique du Solides et Propriétés électroniques, M. BROUSSEAU, Masson 1992.
- Physique des semi-conducteurs et des composants électroniques, H. MATHIEU, Masson 1987.
- Initiation à la Physique du Solide, Exercices commentés, J. CAZAUX, Masson 1989.
- Optoelectronics, E. Rosencher, B. Vinter,P. G. Priva, Masson 1998, Cambridge University Press, 2002

Requirements :
Basic knowledge of Solid-state Physics, Quantum Mechanics. (3rd year of the MNT course) and Physics of electronic devices.

Organisation :
3 hours per week minimum.

Evaluation :
Two-hour written examination.

Target :

Nonlinear Optics	GPM09-ONL
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : PIRON Rozenn	

Objectives :
Study of nonlinear optics and this discipline's major developments and applications. Knowledge on nonlinear optics is relevant
in order to understand optical telecommunications and optical information processing.

Content :
-Introduction to nonlinear optics: Physical origin of nonlinear optics. Requirements on materials. Local electric field impact.
Nonlinear wave equation (light propagation in nonlinear medium). Presentation of nonlinear optical effects.
- Second-order nonlinear optics: Second-harmonic generation. Electro-optic effect. Three-wave mixing. Optical parametric
amplification and oscillation.
- Third-order nonlinear optics: Third-harmonic generation. Optical phase conjugation. Optical bistability. Kerr effect.
Self-focusing, self-phase modulation. Solitons.
- Organic materials for nonlinear optics applications.
- Nonlinear optics for biological applications: Multiphotonic microscopy. Visualisation of electrical potential in biological
environment.

Bibliography :
1. Optique non-linéaire : F. Sanchez - Éditions Ellipse, Grenoble 1999
2. Nonlinear Optics: R.W. Boyd - Academic Press 1992
3. Fundamentals of Photonics: B.E.A. Saleh, M.C. Teich - Wiley Interscience 1991
4. Nonlinear Optics: N. Bloembergen- WA Benjamin, New-York 1965
5. Optical Waves in Crystals, A. Yariv, P. Yeh, John Wiley & Sons 1983
6. Quantum electronics, A. Yariv, John Wiley & Sons 1975

Requirements :
Electromagnetic optics. Anisotropic media. Optics in general.

Organisation :
Two - three hours per week.

Evaluation :
One-hour written examination.

Target :

Case Studies Optoelectronics	GPM09-CIMO
Number of hours : 27.00 h	1.50 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :
5GPM

Advanced Materials Science	GPM09-MAVA
Number of hours : 15.00 h	2.00 ECTS credit
EP : 15.00 h	hand-out in English and course taught in English
Reference Teacher(s) : GLORIANT Thierry, GORDIN Doina-Margareta, THIBON Isabelle	

Objectives :
Familiarisation with bibliographic research, especially using specialised journals and dedicated databases; synthesise and
present the collected information; provide an insight into recent innovations in various fields of materials science.

Content :
A case study on materials and their applications, which should highlight the innovative and prospective aspects of the material.
Students are encouraged to choose from the following materials: composites, nanocomposites, biomaterials, ceramics, special
alloys, metal glasses.

Bibliography :

Requirements :

Organisation :
2 hours per week.

Evaluation :
Oral presentation before the group.
Group discussion.

Target :

Searching and analysing patents	GPM09-SAP
Number of hours : 9.00 h	2.00 ECTS credit
EP : 9.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PERRIN Mathieu	

Objectives :
The purpose of the project is to grasp the basics of patent and work in pairs on a particular topic to learn how to search and analyse patents. The technical field of the patent under study will relate to microelectronics, semiconductor materials, and/or measurement systems, although other topics may be investigated if desired. The project will require a good understanding of the patent documents, patent family structures, scope of protection, etc. , as well as a good command of the search tools and other on-line resources to analyse various aspects of a patent. A technical understanding of the invention and of the prior art cited during the granting procedure is also expected to assess the patent scope and strength. Each group will have to collect the necessary documentation to make a presentation of the project in front of the class at the last session. This course will provide the opportunity for students to demonstrate independence and creativity, and their ability to leverage their formation to tackle new problems involving various aspects (legal, technical, strategical, etc.).

Content :
- Session 1: We will introduce the concept of patent, with a focus on the patent system (patent offices in the world, key features, statistics), the granting procedures, patentability criteria (novelty, inventive step), patent documentation, scope/duration of protection. We will also discuss the free on-line patent tools and resources to search for and analyse patents (build a search strategy, analyse status, scope, strength, etc. of patents). Groups will be formed and the broad technical topic chosen. Typical topics can be in the fields of (micro)electronics, semiconductor materials, and/or measurement systems, but other topics may be chosen by mutual agreement.
- Session 2: For this meeting, students are expected to have found at least one patent, and start reviewing its content. We will put into practice the main notions presented in session 1 on exemplary cases to train how to analyse various aspects of a patent and related family (searches patents, use tools to understand patent family, patent scope, etc.). The goal is to introduce methods of patent search/analysis based on real cases so that each group can then apply them on their project.
- Session 3 (not scheduled): Each team of two students will meet and discuss their project individually with their tutor.
- Session 4: Final presentation of their work by each group, followed by a question-answer session.

Bibliography :

Requirements :
Knowledge of laser physics, such as the Optoelectronics course in 4th year.

Organisation :
A total personal work of 12h is expected from students during the course of the semester. This amounts roughly to 1h30 per week.

Evaluation :
1 oral presentation in front of the class.

Target :

INDUSTRIAL PROJECTS	GPM09-PI
Number of hours : 120.00 h	3.00 ECTS credit
PR : 64.00 h, TA : 56.00 h	
Reference Teacher(s) :	

Objectives :
This course gives the students the opportunity to work in great autonomy on the basis of a specification proposed by industrial companies. The objective is to capitalize on the knowledge and know-how acquired during the training to tackle an open problem, with the ability to explain the method used.
At the end of this project, the students will have
- Answered a real industrial need, at the level of those treated by engineering consulting companies;
- Implemented a project management (anticipation of the work to be provided, management of deadlines and resources);
- Collaborated together as efficiently as possible.

The ability to develop a good team dynamic is an important learning outcome, as each member can create the commitment of others to the project. It is also important to be able to mobilize the expertise of the teachers supervising the project. These teachers are committed to the success of the project, as they are the representatives of INSA's seriousness towards the company.

Content :
In addition to the personal work and exchanges with the teachers, several steps are planned
- General presentation and choice of subjects, constitution of teams
- Detailed presentation of the subject in the presence of the industrial requester
- Drafting of a project guidelines document
- Presentation of teamwork tools for project management (Trello, Kanban)
- Mid-term progress review
- Final defense, presentation of deliverables in the presence of the industrial requester

Bibliography :

Requirements :
Common sense, method and energy.

Organisation :
A list of projects, collected from industrial companies, is presented at the beginning of the school year to the students who are divided into groups of 4 to 6. Each team of students, supervised by one or two teachers, analyses the project and carries it out in a very short time. The students have 120 hours at their disposal, i.e. about 1 day/week for 3.5 months (October-January) and are the driving force behind the project; in particular, they are the ones who initiate the meetings. Not all work hours are placed in the timetables, which are in any case different depending on students' courses, so seriousness is expected in making up for missing hours with personal work.
The students have to make a weekly report to the supervisors, a progress review during the project, a final report as well as a defence in the presence of the industrial requester.

Evaluation :
The follow-up of the project by the educational tutors is done by different means:
• Guidelines document
• Weekly reports to the educational tutors
• Working meetings with the educational tutors
• Report of the mid-term progress review

The evaluation at the end of the project is based on the delivery of three deliverables to the whole jury
• a report, at least one week before the oral presentation date
• all the computer files developed during the project (intermediate reports, PowerPoint presentations, measurement files, CAD, plans, etc.);
• the oral presentation itself.

Target :

Projet Orienté Recherche	GPM09-POR
Number of hours : 120.00 h	3.00 ECTS credit
PR : 64.00 h, TA : 56.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

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

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

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

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

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

Target :

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

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

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

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

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

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

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

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

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Conférences	GPM09-CONF
Number of hours : 24.00 h	0.50 ECTS credit
CONF : 24.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

Microstructures of Materials	GPM09-MIMA
Number of hours : 20.00 h	2.50 ECTS credit
CM : 18.00 h, TP : 0.00 h	
Reference Teacher(s) : GLORIANT Thierry, THIBON Isabelle	

Objectives :
Introduction to thermodynamics and phase transformation in polycrystalline solids.

Content :
General aspects of thermodynamics and phase transformation. Germination and growth mechanisms. Surfaces and interfaces in
crystalline solids. Interphases and grain boundaries: notion of coherence.
Texture and anisotropy in polycrystalline materials. Recovery and recrystallisation.

Bibliography :
J.W. MARTIN, R.D. DOHERTY, Stability of microstructure in metallic systems, Cambridge University Press, London,1976 , ISBN 0.521.20875.0.
D.A. PORTER, K.E.EASTERLING, Phase transformations in metals and alloys, Taylor et Francis Group, 2004, ISBN
0.7487.5741.4.
V.RANDLE, O.ENGLER, Introduction to texture analysis : macrotexture, microtexture and orientation mapping, Gordon and Breach ed., 2000.
F.J.HUMPHREYS, M.HATHERLY, Recrystallization and Related Annealing Phenomena, Pergamon ed., 2004.

Requirements :
Fundamental knowledge of Structural Metallurgy and Crystallography.

Organisation :
Sixty to ninety minutes per week.

Evaluation :
Two-hour written examination.

Target :

MECHANICS OF MATERIALS	GPM09-MECA
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
Study of mechanical properties of materials in correlation with their microstructure.

Content :
1. Physical mechanisms of the mechanical behavior of materials.
2. Constitutive laws of elasto-plasticity.
3. Microscopic plasticity.
4. Macroscopic plasticity.

Bibliography :
- J. PHILIBERT, A. VIGNES, Y. BRECHET, COMBRADE, "" Métallurgie du minerai au matériau "", Masson, 1998
- D. FRANCOIS, A. PINEAU, A. ZAOUI, "" Comportement mécanique des matériaux "", Tome1, Hermes, 1991

Requirements :
Materials science, general mechanics, mechanics of solids.

Organisation :
9 hours.

Evaluation :
1 h examination.

Target :

Biomaterials	GPM09-BIO
Number of hours : 16.00 h	1.50 ECTS credit
CM : 16.00 h, CONF : 0.00 h	
Reference Teacher(s) : GORDIN Doina-Margareta	

Objectives :
To acquire basic notions on biomaterials: properties, synthesis, biomaterials-human body interactions, biomedical applications.

Content :
- Classifications (biocompatibility, biomaterials);
- Natural Biomaterials;
- Metallic Biomaterials;
- Bioceramics;
- Biopolymers;
- Biocomposites;
- Process Synthesis
- Properties: physical, chemical, mechanical, biocompatibility etc;
- Biomaterials-cells, biomaterials-tissues, biomaterials-body fluids;
- Biomechanics: basic notions;
- Biomedical applications.

Bibliography :
Biomaterials Science (Third Edition) An Introduction to Materials in Medicine
Edited by: Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons _ISBN: 978-0-12-374626-9
Introduction to Biomaterials: Basic Theory with Engineering Applications (Cambridge Texts in Biomedical Engineering) 1st Edition, 2013, by , , , ISBN: 978-0521116909.
Essential Biomaterials Science (Cambridge Texts in Biomedical Engineering), 1st Edition, 2014 by , ISBN: 978-0521899086

Requirements :
-Basic Knowledge on Materials (metal, ceramics, polymers, composites);
-Basic Notions in Mechanics, Electrochemistry.

Organisation :
Course 1 hour per week

Evaluation :
1 written examination (1h)

Target :

Materials : selection and conception	GPM09-MACC
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h, TD : 0.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
Selection of the best materials for a given application.

Content :
1.Types of materials.
2.Physical and mechanical parameters for the study of Ashby diagrams.
3.Presentation of a software to select materials.
4.Introduction to Computer-Aid Design (CAD).
5.Use of the CATIA software, examples of application.
6.Fundamental equations of the mechanics of solids.
7.Resolution of problems of mechanics in linear elasticity.

Bibliography :
Michael F. Ashby, David R.H. Jones, Matériaux, Tome 1, Propriétés et applications, Dunod, 1998.
Michael F. Ashby, David R.H. Jones, Matériaux, Tome 2, Microstructure et mise en œuvre, Dunod, 1998.

Requirements :
Metallurgy, general mechanic, Mechanic of solids.

Organisation :
10 h

Evaluation :
1 h examination.

Target :

ASSEMBLIES ENGINEERING : WELDING AND NON DESTRUCTIVE TESTING	GPM09-SCND
Number of hours : 28.00 h	2.00 ECTS credit
CM : 20.00 h, TP : 8.00 h	
Reference Teacher(s) : CORNEN Marilyne, KOUADRI-DAVID Afia	

Objectives :
This course is shared with GMA department for 8h lecture + 8h practical work.
Contact for GMA : Afia KOUADRI DAVID

The first aim of this course is to tackle metallurgy through a widespread technique of assembly welding of metallic alloys. An important point is to understand what kind of microstructure changes during the treatment because those transformations have mechanical consequences on the final assembly. Due to the high speed of cooling or heating during the welding process, the metallurgical changes take place out of equilibrium.

The second aim of this courses is to describe the most commonly used techniques of non destructive testing.

Content :
Introduction: definitions of welding and weldability, concepts of autogenic, homogeneous and heterogeneous welding.
List of welding process.
The welded joint: constitution, elaboration of the fusion zone, solidification structures, structure changes in the heat-affected zone, consequences of the thermal cycles, defects forming.
Welding defects: classification, origins/consequences of faults, remedies to the various troubles encountered.
Control of welded joints.
Introduction to non-destructive testing methods.
Detailed process: visual inspection, liquid penetrant testing, magnetic particle, eddy current testing, ultrasonic, radiographic.

Bibliography :
Métallurgie et mécanique du soudage, Régis Blondeau (Hermès Sciences Publications).
Procédés et applications industrielles du soudage, Régis Blondeau (Hermès Sciences Publications).
Techniques de l ingénieur (B7720, B7730, B7740).
http://www.otua.org/v3/documentation/soudage/assemblage.htm

Termes et définitions utilisés en soudage et techniques connexes, les Publications de la Soudure Autogène et le Conseil International de la Langue Française.
Le contrôle non destructif par ultrasons, Jean Perdijon (Traité des Nouvelles Technologies, série Matériaux, ed. HERMES, 1993)
Les contrôles non destructifs, A. Lambert (Cahiers de formation du CETIM, 1993)
Ultrasons, A. Lambert (Cahiers de formation du CETIM, 1995)
Practical Non-Destructive Testing, B.Raj, T.Jayakumar, M. Thavasimuthu, (Alpha Science International Ltd., Oxford UK, 2007)

Requirements :
General metallurgy, materials microstructures, mechanical properties of metallic alloys.

Organisation :
Personnal work
~ 15h

Evaluation :
1 written exam, duration : 2h.

Target :

Case Studies Materials	GPM09-CIMA
Number of hours : 27.00 h	1.50 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
These courses offer a chance to open the last year training to the world of business by integrating lectures given by engineers coming from different companies.
Apply the teaching to industrial problems.

Content :
Every year the content can change, depending on the engineers accepting to give lessons.

Bibliography :

Requirements :
3GPM et 4GPM training

Organisation :

Evaluation :
Based on the presence, no written exam.

Target :
Public
5GPM students

Renewable Energy	GPM09-ENER
Number of hours : 15.00 h	2.00 ECTS credit
CM : 15.00 h, CONF : 0.00 h	hand-out in English and course taught in English
Reference Teacher(s) : DURAND Olivier	

Objectives :
Taught in the 5th year of studies, this twelve-hour SGM module presents the different renewable energy sources of the 21st century in terms of cost, yield and also impact on the environment. The module begins with an overview of their utilisation, a look at worldwide energy consumption and the economic, environmental and cultural constraints which influence the industrial world. Later, the technical, scientific, economic and environmental aspects of renewable energies (wind-driven, solar, geothermal, biomass, etc.) are presented. Emphasis is put on photovoltaic solar panels which are an expanding field and which are likely to be of interest to future engineers. The presentations may be completed by lectures given by engineers or managers working in the field of renewable energies.

Content :
Presentation of the current energy situation and the role of renewable energies in this context.
Presentation of each renewable energy: wind power, solar energy, geothermal energy, biomass, hydropower, etc.
The different aspects of photovoltaic solar power: crystalline silicon, polycrystalline silicon, amorphous silicon, tandem cells, Grätzel cells, multi-function cells, cells using other materials.

Bibliography :
Energétique : concept et applications : Michel Feidt Systèmes énergétiques : (2004) (bibliothèque insa rennes) Energies renouvelables : (2006) (bibliothèque insa rennes) Renewables energies 2007 rapport de l'IEA (International Energy Agency sur les énergies renouvelables dans le monde)

Requirements :
No specific mathematics tools. The same prerequisites as for the semiconductors modules.
Required knowledge: advanced level in Thermodynamics, yield. Fluid mechanics (Bernouilli equations), semiconductor physics. P-n junction. Quantum Mechanics.

Organisation :
Research on the Internet. Articles from Science publications .

Evaluation :
One-hour written examination.

Target :

Carbon Nanotubes	GPM09-NANO
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : GUEZO Maud	

Objectives :
Properties of carbon nanotubes(structural electronic and optical). Basic methods for the study of nanostructured materials using
X-ray and neutron scattering.

Content :
CARBON NANOTUBES (M. Gicquel):
I. Introduction to the C element (diamond, graphite, nanotubes (NT), fullerene)
II. History of carbon NT (CNT), since 1991(date of discovery).
III. Fabrication techniques for CNT.
IV. Structural properties of CNT.
V. Optical properties of CNT : linear and non linear(absorption, PL, PLE) (pump probe measurements).
VI. Recent and future applications : nanoelectronics, NEMS, fibres, biomedical...
VII. Other NT : BN, SIC, Si.

Bibliography :
A Carbon nanotubes
- "Carbon nanotubes and related structures", Peter J.F. Harris.
- "Physical properties of carbon nanotubes", Dresselhaus, Dresselhaus, Saito.
- "Etude des propriétés optiques des nanotubes de carbone", J.-S. Lauret, thèse de doctorat de l'Université Paris VI, Décembre 2003.
- "Physique de l'état solide", Charles Kittel, 8e édition :nouveau chapitre sur les nanostructures (1D et 0D).-
or in English : "Solid state physics", C. Kittel, Wiley 8th edition.

Requirements :
Properties of semiconductors (3rd and 4th years of MNT).
Structural analysis.
Scattering/diffraction and reciprocal space.

Organisation :
One hour for every hour of lecture time.

Evaluation :
One-hour written examination.

Target :

Biomaterials, biochips and microsystems	GPM09-BPMS
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : PIRON Rozenn	

Objectives :
Use of biology and chemistry orientated applications to set up a multi-disciplinary technology for the development of
microsystems. Presentation of the different biomaterials. Presentation of various biomaterials for medical applications.

Content :
General introduction to biochips: DNA chips, protein chips, chip laboratory, cell chips.
Introduction to microfluidics (overview of hydrodynamics, microsystem mixes, surface effects).
Overview of methods for handling and/or separating chemical or biological substances (electrophoresis, dielectrophoresis,
magnetophoresis, optical tweezers).
Short presentation of microfabrication techniques enabling biomicrosystem manufacturing (etching, PDMS technology, soft
lithography, surface functionalisation).
Introduction to biomaterials.
Main categories of biomaterials (natural biomaterials, synthetic biomaterials).
Interaction between biomaterials and a physiological environment.
Biomaterials in medicine.

Bibliography :
Introduction à la microfluidique - Collection Echelles. Par Tabeling, P. Editions Belin (2003).

Requirements :
Basics of physics, materials science, biology and anatomy.

Organisation :
Two - three hours per week.

Evaluation :
One-hour written examination.

Target :

Optoelectronics 2	GPM09-OPTO
Number of hours : 27.00 h	2.50 ECTS credit
CM : 14.00 h, TD : 13.00 h	
Reference Teacher(s) :	

Objectives :
Final part of solid-state physics with focus on the optical properties of semiconductors. Description of the operating principles
of semiconductor optoelectronic devices (photodetectors, lasers and optical amplifiers).

Content :
- Optical properties of semiconductors: quantum mechanics approach, radiation/semiconductor interaction, optical absorption
in a semiconductor, selection rules for optical transitions, absorption coefficient calculation, (direct or indirect gap), density of
state, calculation of the bimolecular coefficient, calculation of the spontaneous emission spectrum.
- Semiconductor radiation detection devices: Various types of detectors, physical quantities. Noise sources, detection limits.
- Photodetection using photoconductors: photoexcitation in a homogeneous semiconductor, photo-carrier distribution, response
of a photoconductor.
- Photodetection using photodiodes: general overview of photodiodes. Photocurrent calculations, PIN photodiode.
- Other semiconductor detection devices: avalanche photodiode, Schottky photodiode, phototransistor. Image detectors or
imagers: CCD matrices, infrared imager. Semiconductor radiation emitting devices.
- Population inversion in an out-of-equilibrium semiconductor: pseudo-Fermi levels, net emission rate, recombination of
excess carriers, radiative and non-radiative lifetime. Semiconductor Light-Emitting Diodes (LED): operational principle, yield,
recombination mechanisms. Typical structures of LEDs.
- Semiconductor lasers. Radiation amplification in a semiconductor. Threshold current. Spectral distribution of the radiation,
modulation, electrical and optical conconfinement, advantages of double heterostructures.
- Evolution of semiconductor laser structures: response time, cut-off frequency, energy distribution of the radiation, spectral
width.

Bibliography :
- Physique du Solides et Propriétés électroniques, M. BROUSSEAU, Masson 1992.
- Physique des semi-conducteurs et des composants électroniques, H. MATHIEU, Masson 1987.
- Initiation à la Physique du Solide, Exercices commentés, J. CAZAUX, Masson 1989.
- Optoelectronics, E. Rosencher, B. Vinter,P. G. Priva, Masson 1998, Cambridge University Press, 2002

Requirements :
Basic knowledge of Solid-state Physics, Quantum Mechanics. (3rd year of the MNT course) and Physics of electronic devices.

Organisation :
3 hours per week minimum.

Evaluation :
Two-hour written examination.

Target :

Nonlinear Optics	GPM09-ONL
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : PIRON Rozenn	

Objectives :
Study of nonlinear optics and this discipline's major developments and applications. Knowledge on nonlinear optics is relevant
in order to understand optical telecommunications and optical information processing.

Content :
-Introduction to nonlinear optics: Physical origin of nonlinear optics. Requirements on materials. Local electric field impact.
Nonlinear wave equation (light propagation in nonlinear medium). Presentation of nonlinear optical effects.
- Second-order nonlinear optics: Second-harmonic generation. Electro-optic effect. Three-wave mixing. Optical parametric
amplification and oscillation.
- Third-order nonlinear optics: Third-harmonic generation. Optical phase conjugation. Optical bistability. Kerr effect.
Self-focusing, self-phase modulation. Solitons.
- Organic materials for nonlinear optics applications.
- Nonlinear optics for biological applications: Multiphotonic microscopy. Visualisation of electrical potential in biological
environment.

Bibliography :
1. Optique non-linéaire : F. Sanchez - Éditions Ellipse, Grenoble 1999
2. Nonlinear Optics: R.W. Boyd - Academic Press 1992
3. Fundamentals of Photonics: B.E.A. Saleh, M.C. Teich - Wiley Interscience 1991
4. Nonlinear Optics: N. Bloembergen- WA Benjamin, New-York 1965
5. Optical Waves in Crystals, A. Yariv, P. Yeh, John Wiley & Sons 1983
6. Quantum electronics, A. Yariv, John Wiley & Sons 1975

Requirements :
Electromagnetic optics. Anisotropic media. Optics in general.

Organisation :
Two - three hours per week.

Evaluation :
One-hour written examination.

Target :

Case Studies Optoelectronics	GPM09-CIMO
Number of hours : 27.00 h	1.50 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :
5GPM

Semestre 9

Parcours Formation Initiale GPM

1	**GPM09-1**		**Emerging technologies**	**10.00**
	GPM09-MIMA	O	Microstructures of Materials	2.50
	GPM09-MECA	O	MECHANICS OF MATERIALS	1.00
	GPM09-BIO	O	Biomaterials	1.50
	GPM09-MACC	O	Materials : selection and conception	1.50
	GPM09-SCND	O	ASSEMBLIES ENGINEERING : WELDING AND NON DESTRUCTIVE TESTING	2.00
	GPM09-CIMA	O	Case Studies Materials	1.50
2	**GPM09-2**		**Materials Science 4**	**9.50**
	GPM09-ENER	O	Renewable Energy	2.00
	GPM09-NANO	O	Carbon Nanotubes	1.00
	GPM09-BPMS	O	Biomaterials, biochips and microsystems	1.00
	GPM09-OPTO	O	Optoelectronics 2	2.50
	GPM09-ONL	O	Nonlinear Optics	1.50
	GPM09-CIMO	O	Case Studies Optoelectronics	1.50
3	**GPM09-3**		**Enseignement scientifiques à choix S9**	**2.00**
	GPM09-MAVA	C	Advanced Materials Science	2.00
	GPM09-SAP	C	Searching and analysing patents	2.00
4	**GPM09-4**		**Projets**	**3.00**
	GPM09-PI	C	INDUSTRIAL PROJECTS	3.00
	GPM09-POR	C	Projet Orienté Recherche	3.00
5	**HUM09-GPM**		**HUMANITES**	**5.50**
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-PM-A	C	Economics, Law and Business Studies A - LEAN 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
	HUM09-PM-G	C	Economics, Law and Business Studies G (serious game)	2.00
	GPM09-CONF	O	Conférences	0.50
6	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00

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

Microstructures of Materials	GPM09-MIMA
Number of hours : 20.00 h	2.50 ECTS credit
CM : 18.00 h, TP : 0.00 h	
Reference Teacher(s) : GLORIANT Thierry, THIBON Isabelle	

Objectives :
Introduction to thermodynamics and phase transformation in polycrystalline solids.

Content :
General aspects of thermodynamics and phase transformation. Germination and growth mechanisms. Surfaces and interfaces in
crystalline solids. Interphases and grain boundaries: notion of coherence.
Texture and anisotropy in polycrystalline materials. Recovery and recrystallisation.

Bibliography :
J.W. MARTIN, R.D. DOHERTY, Stability of microstructure in metallic systems, Cambridge University Press, London,1976 , ISBN 0.521.20875.0.
D.A. PORTER, K.E.EASTERLING, Phase transformations in metals and alloys, Taylor et Francis Group, 2004, ISBN
0.7487.5741.4.
V.RANDLE, O.ENGLER, Introduction to texture analysis : macrotexture, microtexture and orientation mapping, Gordon and Breach ed., 2000.
F.J.HUMPHREYS, M.HATHERLY, Recrystallization and Related Annealing Phenomena, Pergamon ed., 2004.

Requirements :
Fundamental knowledge of Structural Metallurgy and Crystallography.

Organisation :
Sixty to ninety minutes per week.

Evaluation :
Two-hour written examination.

Target :

MECHANICS OF MATERIALS	GPM09-MECA
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
Study of mechanical properties of materials in correlation with their microstructure.

Content :
1. Physical mechanisms of the mechanical behavior of materials.
2. Constitutive laws of elasto-plasticity.
3. Microscopic plasticity.
4. Macroscopic plasticity.

Bibliography :
- J. PHILIBERT, A. VIGNES, Y. BRECHET, COMBRADE, "" Métallurgie du minerai au matériau "", Masson, 1998
- D. FRANCOIS, A. PINEAU, A. ZAOUI, "" Comportement mécanique des matériaux "", Tome1, Hermes, 1991

Requirements :
Materials science, general mechanics, mechanics of solids.

Organisation :
9 hours.

Evaluation :
1 h examination.

Target :

Biomaterials	GPM09-BIO
Number of hours : 16.00 h	1.50 ECTS credit
CM : 16.00 h, CONF : 0.00 h	
Reference Teacher(s) : GORDIN Doina-Margareta	

Objectives :
To acquire basic notions on biomaterials: properties, synthesis, biomaterials-human body interactions, biomedical applications.

Content :
- Classifications (biocompatibility, biomaterials);
- Natural Biomaterials;
- Metallic Biomaterials;
- Bioceramics;
- Biopolymers;
- Biocomposites;
- Process Synthesis
- Properties: physical, chemical, mechanical, biocompatibility etc;
- Biomaterials-cells, biomaterials-tissues, biomaterials-body fluids;
- Biomechanics: basic notions;
- Biomedical applications.

Bibliography :
Biomaterials Science (Third Edition) An Introduction to Materials in Medicine
Edited by: Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons _ISBN: 978-0-12-374626-9
Introduction to Biomaterials: Basic Theory with Engineering Applications (Cambridge Texts in Biomedical Engineering) 1st Edition, 2013, by , , , ISBN: 978-0521116909.
Essential Biomaterials Science (Cambridge Texts in Biomedical Engineering), 1st Edition, 2014 by , ISBN: 978-0521899086

Requirements :
-Basic Knowledge on Materials (metal, ceramics, polymers, composites);
-Basic Notions in Mechanics, Electrochemistry.

Organisation :
Course 1 hour per week

Evaluation :
1 written examination (1h)

Target :

Materials : selection and conception	GPM09-MACC
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h, TD : 0.00 h	
Reference Teacher(s) : FRANCILLETTE Henri	

Objectives :
Selection of the best materials for a given application.

Content :
1.Types of materials.
2.Physical and mechanical parameters for the study of Ashby diagrams.
3.Presentation of a software to select materials.
4.Introduction to Computer-Aid Design (CAD).
5.Use of the CATIA software, examples of application.
6.Fundamental equations of the mechanics of solids.
7.Resolution of problems of mechanics in linear elasticity.

Bibliography :
Michael F. Ashby, David R.H. Jones, Matériaux, Tome 1, Propriétés et applications, Dunod, 1998.
Michael F. Ashby, David R.H. Jones, Matériaux, Tome 2, Microstructure et mise en œuvre, Dunod, 1998.

Requirements :
Metallurgy, general mechanic, Mechanic of solids.

Organisation :
10 h

Evaluation :
1 h examination.

Target :

ASSEMBLIES ENGINEERING : WELDING AND NON DESTRUCTIVE TESTING	GPM09-SCND
Number of hours : 28.00 h	2.00 ECTS credit
CM : 20.00 h, TP : 8.00 h	
Reference Teacher(s) : CORNEN Marilyne, KOUADRI-DAVID Afia	

Objectives :
This course is shared with GMA department for 8h lecture + 8h practical work.
Contact for GMA : Afia KOUADRI DAVID

The first aim of this course is to tackle metallurgy through a widespread technique of assembly welding of metallic alloys. An important point is to understand what kind of microstructure changes during the treatment because those transformations have mechanical consequences on the final assembly. Due to the high speed of cooling or heating during the welding process, the metallurgical changes take place out of equilibrium.

The second aim of this courses is to describe the most commonly used techniques of non destructive testing.

Content :
Introduction: definitions of welding and weldability, concepts of autogenic, homogeneous and heterogeneous welding.
List of welding process.
The welded joint: constitution, elaboration of the fusion zone, solidification structures, structure changes in the heat-affected zone, consequences of the thermal cycles, defects forming.
Welding defects: classification, origins/consequences of faults, remedies to the various troubles encountered.
Control of welded joints.
Introduction to non-destructive testing methods.
Detailed process: visual inspection, liquid penetrant testing, magnetic particle, eddy current testing, ultrasonic, radiographic.

Bibliography :
Métallurgie et mécanique du soudage, Régis Blondeau (Hermès Sciences Publications).
Procédés et applications industrielles du soudage, Régis Blondeau (Hermès Sciences Publications).
Techniques de l ingénieur (B7720, B7730, B7740).
http://www.otua.org/v3/documentation/soudage/assemblage.htm

Termes et définitions utilisés en soudage et techniques connexes, les Publications de la Soudure Autogène et le Conseil International de la Langue Française.
Le contrôle non destructif par ultrasons, Jean Perdijon (Traité des Nouvelles Technologies, série Matériaux, ed. HERMES, 1993)
Les contrôles non destructifs, A. Lambert (Cahiers de formation du CETIM, 1993)
Ultrasons, A. Lambert (Cahiers de formation du CETIM, 1995)
Practical Non-Destructive Testing, B.Raj, T.Jayakumar, M. Thavasimuthu, (Alpha Science International Ltd., Oxford UK, 2007)

Requirements :
General metallurgy, materials microstructures, mechanical properties of metallic alloys.

Organisation :
Personnal work
~ 15h

Evaluation :
1 written exam, duration : 2h.

Target :

Case Studies Materials	GPM09-CIMA
Number of hours : 27.00 h	1.50 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :
These courses offer a chance to open the last year training to the world of business by integrating lectures given by engineers coming from different companies.
Apply the teaching to industrial problems.

Content :
Every year the content can change, depending on the engineers accepting to give lessons.

Bibliography :

Requirements :
3GPM et 4GPM training

Organisation :

Evaluation :
Based on the presence, no written exam.

Target :
Public
5GPM students

Renewable Energy	GPM09-ENER
Number of hours : 15.00 h	2.00 ECTS credit
CM : 15.00 h, CONF : 0.00 h	hand-out in English and course taught in English
Reference Teacher(s) : DURAND Olivier	

Objectives :
Taught in the 5th year of studies, this twelve-hour SGM module presents the different renewable energy sources of the 21st century in terms of cost, yield and also impact on the environment. The module begins with an overview of their utilisation, a look at worldwide energy consumption and the economic, environmental and cultural constraints which influence the industrial world. Later, the technical, scientific, economic and environmental aspects of renewable energies (wind-driven, solar, geothermal, biomass, etc.) are presented. Emphasis is put on photovoltaic solar panels which are an expanding field and which are likely to be of interest to future engineers. The presentations may be completed by lectures given by engineers or managers working in the field of renewable energies.

Content :
Presentation of the current energy situation and the role of renewable energies in this context.
Presentation of each renewable energy: wind power, solar energy, geothermal energy, biomass, hydropower, etc.
The different aspects of photovoltaic solar power: crystalline silicon, polycrystalline silicon, amorphous silicon, tandem cells, Grätzel cells, multi-function cells, cells using other materials.

Bibliography :
Energétique : concept et applications : Michel Feidt Systèmes énergétiques : (2004) (bibliothèque insa rennes) Energies renouvelables : (2006) (bibliothèque insa rennes) Renewables energies 2007 rapport de l'IEA (International Energy Agency sur les énergies renouvelables dans le monde)

Requirements :
No specific mathematics tools. The same prerequisites as for the semiconductors modules.
Required knowledge: advanced level in Thermodynamics, yield. Fluid mechanics (Bernouilli equations), semiconductor physics. P-n junction. Quantum Mechanics.

Organisation :
Research on the Internet. Articles from Science publications .

Evaluation :
One-hour written examination.

Target :

Carbon Nanotubes	GPM09-NANO
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : GUEZO Maud	

Objectives :
Properties of carbon nanotubes(structural electronic and optical). Basic methods for the study of nanostructured materials using
X-ray and neutron scattering.

Content :
CARBON NANOTUBES (M. Gicquel):
I. Introduction to the C element (diamond, graphite, nanotubes (NT), fullerene)
II. History of carbon NT (CNT), since 1991(date of discovery).
III. Fabrication techniques for CNT.
IV. Structural properties of CNT.
V. Optical properties of CNT : linear and non linear(absorption, PL, PLE) (pump probe measurements).
VI. Recent and future applications : nanoelectronics, NEMS, fibres, biomedical...
VII. Other NT : BN, SIC, Si.

Bibliography :
A Carbon nanotubes
- "Carbon nanotubes and related structures", Peter J.F. Harris.
- "Physical properties of carbon nanotubes", Dresselhaus, Dresselhaus, Saito.
- "Etude des propriétés optiques des nanotubes de carbone", J.-S. Lauret, thèse de doctorat de l'Université Paris VI, Décembre 2003.
- "Physique de l'état solide", Charles Kittel, 8e édition :nouveau chapitre sur les nanostructures (1D et 0D).-
or in English : "Solid state physics", C. Kittel, Wiley 8th edition.

Requirements :
Properties of semiconductors (3rd and 4th years of MNT).
Structural analysis.
Scattering/diffraction and reciprocal space.

Organisation :
One hour for every hour of lecture time.

Evaluation :
One-hour written examination.

Target :

Biomaterials, biochips and microsystems	GPM09-BPMS
Number of hours : 9.00 h	1.00 ECTS credit
CM : 9.00 h	
Reference Teacher(s) : PIRON Rozenn	

Objectives :
Use of biology and chemistry orientated applications to set up a multi-disciplinary technology for the development of
microsystems. Presentation of the different biomaterials. Presentation of various biomaterials for medical applications.

Content :
General introduction to biochips: DNA chips, protein chips, chip laboratory, cell chips.
Introduction to microfluidics (overview of hydrodynamics, microsystem mixes, surface effects).
Overview of methods for handling and/or separating chemical or biological substances (electrophoresis, dielectrophoresis,
magnetophoresis, optical tweezers).
Short presentation of microfabrication techniques enabling biomicrosystem manufacturing (etching, PDMS technology, soft
lithography, surface functionalisation).
Introduction to biomaterials.
Main categories of biomaterials (natural biomaterials, synthetic biomaterials).
Interaction between biomaterials and a physiological environment.
Biomaterials in medicine.

Bibliography :
Introduction à la microfluidique - Collection Echelles. Par Tabeling, P. Editions Belin (2003).

Requirements :
Basics of physics, materials science, biology and anatomy.

Organisation :
Two - three hours per week.

Evaluation :
One-hour written examination.

Target :

Optoelectronics 2	GPM09-OPTO
Number of hours : 27.00 h	2.50 ECTS credit
CM : 14.00 h, TD : 13.00 h	
Reference Teacher(s) :	

Objectives :
Final part of solid-state physics with focus on the optical properties of semiconductors. Description of the operating principles
of semiconductor optoelectronic devices (photodetectors, lasers and optical amplifiers).

Content :
- Optical properties of semiconductors: quantum mechanics approach, radiation/semiconductor interaction, optical absorption
in a semiconductor, selection rules for optical transitions, absorption coefficient calculation, (direct or indirect gap), density of
state, calculation of the bimolecular coefficient, calculation of the spontaneous emission spectrum.
- Semiconductor radiation detection devices: Various types of detectors, physical quantities. Noise sources, detection limits.
- Photodetection using photoconductors: photoexcitation in a homogeneous semiconductor, photo-carrier distribution, response
of a photoconductor.
- Photodetection using photodiodes: general overview of photodiodes. Photocurrent calculations, PIN photodiode.
- Other semiconductor detection devices: avalanche photodiode, Schottky photodiode, phototransistor. Image detectors or
imagers: CCD matrices, infrared imager. Semiconductor radiation emitting devices.
- Population inversion in an out-of-equilibrium semiconductor: pseudo-Fermi levels, net emission rate, recombination of
excess carriers, radiative and non-radiative lifetime. Semiconductor Light-Emitting Diodes (LED): operational principle, yield,
recombination mechanisms. Typical structures of LEDs.
- Semiconductor lasers. Radiation amplification in a semiconductor. Threshold current. Spectral distribution of the radiation,
modulation, electrical and optical conconfinement, advantages of double heterostructures.
- Evolution of semiconductor laser structures: response time, cut-off frequency, energy distribution of the radiation, spectral
width.

Bibliography :
- Physique du Solides et Propriétés électroniques, M. BROUSSEAU, Masson 1992.
- Physique des semi-conducteurs et des composants électroniques, H. MATHIEU, Masson 1987.
- Initiation à la Physique du Solide, Exercices commentés, J. CAZAUX, Masson 1989.
- Optoelectronics, E. Rosencher, B. Vinter,P. G. Priva, Masson 1998, Cambridge University Press, 2002

Requirements :
Basic knowledge of Solid-state Physics, Quantum Mechanics. (3rd year of the MNT course) and Physics of electronic devices.

Organisation :
3 hours per week minimum.

Evaluation :
Two-hour written examination.

Target :

Nonlinear Optics	GPM09-ONL
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : PIRON Rozenn	

Objectives :
Study of nonlinear optics and this discipline's major developments and applications. Knowledge on nonlinear optics is relevant
in order to understand optical telecommunications and optical information processing.

Content :
-Introduction to nonlinear optics: Physical origin of nonlinear optics. Requirements on materials. Local electric field impact.
Nonlinear wave equation (light propagation in nonlinear medium). Presentation of nonlinear optical effects.
- Second-order nonlinear optics: Second-harmonic generation. Electro-optic effect. Three-wave mixing. Optical parametric
amplification and oscillation.
- Third-order nonlinear optics: Third-harmonic generation. Optical phase conjugation. Optical bistability. Kerr effect.
Self-focusing, self-phase modulation. Solitons.
- Organic materials for nonlinear optics applications.
- Nonlinear optics for biological applications: Multiphotonic microscopy. Visualisation of electrical potential in biological
environment.

Bibliography :
1. Optique non-linéaire : F. Sanchez - Éditions Ellipse, Grenoble 1999
2. Nonlinear Optics: R.W. Boyd - Academic Press 1992
3. Fundamentals of Photonics: B.E.A. Saleh, M.C. Teich - Wiley Interscience 1991
4. Nonlinear Optics: N. Bloembergen- WA Benjamin, New-York 1965
5. Optical Waves in Crystals, A. Yariv, P. Yeh, John Wiley & Sons 1983
6. Quantum electronics, A. Yariv, John Wiley & Sons 1975

Requirements :
Electromagnetic optics. Anisotropic media. Optics in general.

Organisation :
Two - three hours per week.

Evaluation :
One-hour written examination.

Target :

Case Studies Optoelectronics	GPM09-CIMO
Number of hours : 27.00 h	1.50 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :
5GPM

Advanced Materials Science	GPM09-MAVA
Number of hours : 15.00 h	2.00 ECTS credit
EP : 15.00 h	hand-out in English and course taught in English
Reference Teacher(s) : GLORIANT Thierry, GORDIN Doina-Margareta, THIBON Isabelle	

Objectives :
Familiarisation with bibliographic research, especially using specialised journals and dedicated databases; synthesise and
present the collected information; provide an insight into recent innovations in various fields of materials science.

Content :
A case study on materials and their applications, which should highlight the innovative and prospective aspects of the material.
Students are encouraged to choose from the following materials: composites, nanocomposites, biomaterials, ceramics, special
alloys, metal glasses.

Bibliography :

Requirements :

Organisation :
2 hours per week.

Evaluation :
Oral presentation before the group.
Group discussion.

Target :

Searching and analysing patents	GPM09-SAP
Number of hours : 9.00 h	2.00 ECTS credit
EP : 9.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PERRIN Mathieu	

Objectives :
The purpose of the project is to grasp the basics of patent and work in pairs on a particular topic to learn how to search and analyse patents. The technical field of the patent under study will relate to microelectronics, semiconductor materials, and/or measurement systems, although other topics may be investigated if desired. The project will require a good understanding of the patent documents, patent family structures, scope of protection, etc. , as well as a good command of the search tools and other on-line resources to analyse various aspects of a patent. A technical understanding of the invention and of the prior art cited during the granting procedure is also expected to assess the patent scope and strength. Each group will have to collect the necessary documentation to make a presentation of the project in front of the class at the last session. This course will provide the opportunity for students to demonstrate independence and creativity, and their ability to leverage their formation to tackle new problems involving various aspects (legal, technical, strategical, etc.).

Content :
- Session 1: We will introduce the concept of patent, with a focus on the patent system (patent offices in the world, key features, statistics), the granting procedures, patentability criteria (novelty, inventive step), patent documentation, scope/duration of protection. We will also discuss the free on-line patent tools and resources to search for and analyse patents (build a search strategy, analyse status, scope, strength, etc. of patents). Groups will be formed and the broad technical topic chosen. Typical topics can be in the fields of (micro)electronics, semiconductor materials, and/or measurement systems, but other topics may be chosen by mutual agreement.
- Session 2: For this meeting, students are expected to have found at least one patent, and start reviewing its content. We will put into practice the main notions presented in session 1 on exemplary cases to train how to analyse various aspects of a patent and related family (searches patents, use tools to understand patent family, patent scope, etc.). The goal is to introduce methods of patent search/analysis based on real cases so that each group can then apply them on their project.
- Session 3 (not scheduled): Each team of two students will meet and discuss their project individually with their tutor.
- Session 4: Final presentation of their work by each group, followed by a question-answer session.

Bibliography :

Requirements :
Knowledge of laser physics, such as the Optoelectronics course in 4th year.

Organisation :
A total personal work of 12h is expected from students during the course of the semester. This amounts roughly to 1h30 per week.

Evaluation :
1 oral presentation in front of the class.

Target :

INDUSTRIAL PROJECTS	GPM09-PI
Number of hours : 120.00 h	3.00 ECTS credit
PR : 64.00 h, TA : 56.00 h	
Reference Teacher(s) :	

Objectives :
This course gives the students the opportunity to work in great autonomy on the basis of a specification proposed by industrial companies. The objective is to capitalize on the knowledge and know-how acquired during the training to tackle an open problem, with the ability to explain the method used.
At the end of this project, the students will have
- Answered a real industrial need, at the level of those treated by engineering consulting companies;
- Implemented a project management (anticipation of the work to be provided, management of deadlines and resources);
- Collaborated together as efficiently as possible.

The ability to develop a good team dynamic is an important learning outcome, as each member can create the commitment of others to the project. It is also important to be able to mobilize the expertise of the teachers supervising the project. These teachers are committed to the success of the project, as they are the representatives of INSA's seriousness towards the company.

Content :
In addition to the personal work and exchanges with the teachers, several steps are planned
- General presentation and choice of subjects, constitution of teams
- Detailed presentation of the subject in the presence of the industrial requester
- Drafting of a project guidelines document
- Presentation of teamwork tools for project management (Trello, Kanban)
- Mid-term progress review
- Final defense, presentation of deliverables in the presence of the industrial requester

Bibliography :

Requirements :
Common sense, method and energy.

Organisation :
A list of projects, collected from industrial companies, is presented at the beginning of the school year to the students who are divided into groups of 4 to 6. Each team of students, supervised by one or two teachers, analyses the project and carries it out in a very short time. The students have 120 hours at their disposal, i.e. about 1 day/week for 3.5 months (October-January) and are the driving force behind the project; in particular, they are the ones who initiate the meetings. Not all work hours are placed in the timetables, which are in any case different depending on students' courses, so seriousness is expected in making up for missing hours with personal work.
The students have to make a weekly report to the supervisors, a progress review during the project, a final report as well as a defence in the presence of the industrial requester.

Evaluation :
The follow-up of the project by the educational tutors is done by different means:
• Guidelines document
• Weekly reports to the educational tutors
• Working meetings with the educational tutors
• Report of the mid-term progress review

The evaluation at the end of the project is based on the delivery of three deliverables to the whole jury
• a report, at least one week before the oral presentation date
• all the computer files developed during the project (intermediate reports, PowerPoint presentations, measurement files, CAD, plans, etc.);
• the oral presentation itself.

Target :

Projet Orienté Recherche	GPM09-POR
Number of hours : 120.00 h	3.00 ECTS credit
PR : 64.00 h, TA : 56.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

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

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

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

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

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

Target :

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

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

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

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

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

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

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

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

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

Objectives :
The Management Course shoudl enable students:
to engage with «management-oriented» themes d'aborder des thèmes « orientés métiers » relative to management,
to personnalise 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 identifed 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 managament, « 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 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. Eacg 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 :

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

Objectives :
Objectives of Management Courses
The Management Course shoudl enable students:
to engage with «management-oriented» themes relative to management,
to personnalise 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 identifed 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 jursiprudence.

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 band development. In this context, man 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 motivatioon
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 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. Eacg 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 :

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

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.
Main learning outcomes are:
-Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

Content :
- 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 :

Economics, Law and Business Studies E (INTERNATIONAL DEVELOPPEMENT & STRATEGIES)	HUM09-PM-E
Number of hours : 34.00 h	2.00 ECTS credit
CM : 30.00 h, TD : 4.00 h	
Reference Teacher(s) : GOURRET Fanny	

Objectives :
This course aims to enable students to develop specific management skills in accordance with their personal objectives and professional motivations. Students chose one option among six.
Main learning outcomes are:
- Establishing a strong, specific vocabulary base
- Understanding the main issues that industrial companies deal with (in a specific management field).
- Understanding the importance of teamwork : making collective decisions and producing the expected work in time

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

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 :

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

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 Developmet 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. Eacg 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 :

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

Conférences	GPM09-CONF
Number of hours : 24.00 h	0.50 ECTS credit
CONF : 24.00 h	
Reference Teacher(s) : LETOUBLON Antoine	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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 10

Parcours Contrat Professionnel

1	GPM10-PFE		Projet de Fin d'Etudes	30.00
	GPM10-PFE	O	Final Year Project	30.00

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

Final Year Project	GPM10-PFE
Number of hours : 350.00 h	30.00 ECTS credit
ST : 350.00 h	
Reference Teacher(s) : LEVALLOIS Christophe	

Objectives :
This fifth year work placement is a sixteen-week (minimum) period spent either in a company or research laboratory. It must take place during the last semester, and must enable students to put into practice the knowledge acquired on the course and to enrich their competence in their chosen domain. Finding the placement and the placement itself will prepare the students for job seeking and the professional career they are soon to embark upon. Each proposal must be approved by the person in charge
of work placements and the Director of the department.
The final mark gives up to 30 ECTS credits.

Content :
Finding the placement is up to the student's own initiative: contacting the host establishment, job interview.
Length of the placement: 16 weeks minimum.(six months maximum)
Period: from February onwards.

Bibliography :

Requirements :
Level corresponding to five semesters of training on the course.

Organisation :
Full-time work in the host establishment.

Evaluation :
Supervisor's assessment (given with the report).
The fifth year placement report (may be written in English or French).
Oral presentation before a jury composed of 3 teachers from the MNT department.
Final evaluation will be given in terms of a mark scaled from 0 to 20.

Target :

Semestre 10

Parcours Formation Initiale GPM

1	GPM10-PFE		Projet de Fin d'Etudes	30.00
	GPM10-PFE	O	Final Year Project	30.00

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

Final Year Project	GPM10-PFE
Number of hours : 350.00 h	30.00 ECTS credit
ST : 350.00 h	
Reference Teacher(s) : LEVALLOIS Christophe	

Objectives :
This fifth year work placement is a sixteen-week (minimum) period spent either in a company or research laboratory. It must take place during the last semester, and must enable students to put into practice the knowledge acquired on the course and to enrich their competence in their chosen domain. Finding the placement and the placement itself will prepare the students for job seeking and the professional career they are soon to embark upon. Each proposal must be approved by the person in charge
of work placements and the Director of the department.
The final mark gives up to 30 ECTS credits.

Content :
Finding the placement is up to the student's own initiative: contacting the host establishment, job interview.
Length of the placement: 16 weeks minimum.(six months maximum)
Period: from February onwards.

Bibliography :

Requirements :
Level corresponding to five semesters of training on the course.

Organisation :
Full-time work in the host establishment.

Evaluation :
Supervisor's assessment (given with the report).
The fifth year placement report (may be written in English or French).
Oral presentation before a jury composed of 3 teachers from the MNT department.
Final evaluation will be given in terms of a mark scaled from 0 to 20.

Target :