INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES

Academic year 2020/2021

Courses offered by the programme

Science et Génie des Matériaux (SGM)

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

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

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

Code	Libelle
SGM09-ALP	Applications of lasers and photonics
SGM09-ECND	Elaboration and characterisation of nanostructures and Devices
SGM09-ENER	Renewable Energy
SGM09-ONL	Nonlinear Optics

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

CRYSTALLOGRAPHY	SGM07-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 :
Homework: approximately 2 hours per week.

Evaluation :
Two-hours written examination.

Target :

STRUCTURAL ANALYSIS OF MATERIALS BY X-RAY SCATTERING AND DIFFRACTION	SGM07-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 sin²_ 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 and methods.

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	SGM07-MECA
Number of hours : 30.00 h	3.50 ECTS credit
CM : 22.00 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	SGM07-TPMA
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
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 :

ELECTRONIC FUNCTIONS	SGM07-ELEC
Number of hours : 102.00 h	4.00 ECTS credit
CM : 12.00 h, EP : 64.00 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	SGM07-DISP
Number of hours : 33.00 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	SGM07-TPPED
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
Reference Teacher(s) : BERTRU NICOLAS, PARANTHOEN CYRIL	

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 :

	SGM07-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 :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Design of experiments methodology	SGM07-PLAN
Number of hours : 14.00 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	SGM07-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 :

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 :

3 MNT Work Placement	SGM07-STA3
Number of hours : 240.00 h	4.00 ECTS credit
DIV : 6.00 h	
Reference Teacher(s) : LEVALLOIS CHRISTOPHE	

Objectives :
In the third year of the course, there is an option of undertaking a four-week placement in a company or research laboratory.
The internship must take place between the end of the third year and the beginning of the fourth year. Seeking the placement
and the placement itself will prepare the student for job seeking. The validation of the placement gives 4 ECTS credits.

Content :
Seeking of the placement is up to the student's own initiative: making contact with the host establishment; job interviews.
Period: from the beginning of June onwards.

Bibliography :

Requirements :
Level corresponding to one semester of training on the course.

Organisation :
Full-time work in the host establishment.

Evaluation :
Validation system: Report written in French or in English.

Target :

Stages 3SGM 2CR	SGM07-STA3 2CR
Number of hours : 240.00 h	2.00 ECTS credit
DIV : 6.00 h	
Reference Teacher(s) : LEVALLOIS CHRISTOPHE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Stages 3SGM 3CR	SGM07-STA3 3CR
Number of hours : 240.00 h	3.00 ECTS credit
DIV : 6.00 h	
Reference Teacher(s) : LEVALLOIS CHRISTOPHE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Light engineering for theatre with studies	HUMF1-LUM
Number of hours : 2.30 h	1.00 ECTS credit
DIV : 2.30 h, DIV : 2.30 h	
Reference Teacher(s) : MERIC STEPHANE	

Objectives :
Teach students how to deal with the technical aspects of theatre plays, concerts, public-address systems for conferences, recordings...

Content :
Microphones, sound recording, sound software,stage/light mixing techniques, lighting desks and sound control systems : theoretical and practical experience.

Bibliography :

Requirements :
None

Organisation :
Workshops on Thurday afternoon in local venues or at INSA

Evaluation :
Validation of first semester (no mark awarded)

Target :
Any year

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 8

Parcours Formation Initiale SGM

1	**SGM08-1**		**Materials Science 2**	**4.00**
	SGM08-DIFF	O	Diffusion in Solids	1.50
	SGM08-TCM	O	Techniques de caractérisation des matériaux	1.00
	SGM08-TPMA	O	LABORATORY : MATERIALS 2	1.50
2	**SGM08-2**		**Electronic Devices Technology 2**	**6.50**
	SGM08-TCSI	O	Silicon Devices Technology	1.50
	SGM08-TPSB1	C	CCMO Clean room experimental work	1.00
	SGM08-TPSB2	C	TOP35 Clean room experimental work	1.00
	SGM08-POM	O	Optical Properties of Materials	2.50
	SGM08-TPPED	O	Electronic and Opto. Properties of Solid-Based Devices	1.50
3	**SGM08-3**		**Electronic & Measurement 2**	**5.50**
	SGM08-PSM	O	Projet de simulation de matériaux	2.50
	SGM08-LAB	O	LABVIEW CORE 2	2.50
	SGM08-CONF	O	Conferences	0.50
4	**SGM08-4**		**STAGE S8**	**8.00**
	SGM08-STA4	O	4th year Work Placement	8.00
5	**HUM08**		**Non-scientific syllabus S8**	**6.00**
	HUM08-ANGL	O	English	2.00
	HUM08-ECO	O	Economy and Management	1.00
	HUM08-SHES1	O	Engineer & Society - M1	1.00
	HUM08-SHES2	O	Engineer & Society - M2	1.00
	HUM08-EPS	O	Sport and Physical Education	1.00

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

Diffusion in Solids	SGM08-DIFF
Number of hours : 32.00 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	SGM08-TCM
Number of hours : 18.00 h	1.00 ECTS credit
CM : 12.00 h, TD : 6.00 h	
Reference Teacher(s) : CASTANY PHILIPPE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

LABORATORY : MATERIALS 2	SGM08-TPMA
Number of hours : 32.00 h	1.50 ECTS credit
TP : 32.00 h	
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 :

Silicon Devices Technology	SGM08-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	SGM08-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	SGM08-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	SGM08-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	SGM08-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 :

Projet de simulation de matériaux	SGM08-PSM
Number of hours : 36.00 h	2.50 ECTS credit
EP : 12.00 h	
Reference Teacher(s) : FRANCILLETTE HENRI	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

LABVIEW CORE 2	SGM08-LAB
Number of hours : 33.00 h	2.50 ECTS credit
EP : 1.00 h, EP : 11.00 h, PR : 9.00 h, TP : 12.00 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 :

Conferences	SGM08-CONF
Number of hours : 15.00 h	0.50 ECTS credit
CONF : 15.00 h, 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	SGM08-STA4
Number of hours : 243.00 h	8.00 ECTS credit
DIV : 3.00 h, DIV : 3.00 h, ST : 240.00 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, TD : 24.00 h	
Reference Teacher(s) :	

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

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

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

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

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

Evaluation :
TOEIC
15 minute oral exam

Target :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

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

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

Requirements :

Organisation :

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

Target :

Semestre 9

Parcours Formation Initiale SGM

1	**SGM09-1**		**Emerging technologies**	**11.00**
	SGM09-MIMA	O	Microstructures of Materials	2.00
	SGM09-MECA	O	MECHANICS OF MATERIALS	1.00
	SGM09-COMP	O	COMPOSITES	1.50
	SGM09-BIO	O	Biomaterials	1.50
	SGM09-MACC	O	MATERIALS : SELECTION AND CONCEPTION	1.50
	SGM09-SCND	O	ASSEMBLIES ENGINEERING : WELDING AND NON DESTRUCTIVE TESTING	1.50
	SGM09-CIMA	O	Case Studies Core Courses	2.00
2	**SGM09-2**		**Materials Science 4**	**11.50**
	SGM09-ECND	O	Elaboration and characterisation of nanostructures and Devices	2.00
	SGM09-ENER	O	Renewable Energy	1.50
	SGM09-NANO	O	Carbon Nanotubes	1.00
	SGM09-BPMS	O	Biomaterials, biochips and microsystems	1.00
	SGM09-OPTO	O	Optoelectronics 2	2.50
	SGM09-ONL	O	Nonlinear Optics	1.50
	SGM09-CIMO	O	Cas Industriels micro-optoélectronique	2.00
3	**SGM09-3**		**Enseignement scientifiques à choix S9**	**2.00**
	SGM09-MAVA	C	Advanced Materials Science	2.00
	SGM09-ALP	C	Applications of lasers and photonics	2.00
4	**HUM09-SGM**		**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 six sigma)	2.00
	HUM09-PM-B	C	Economics, Law and Business Studies B (Human Resource Management)	2.00
	HUM09-PM-C	C	Economics, Law and Business Studies C (Human Resources Management)	2.00
	HUM09-PM-D	C	Economics, Law and Business Studies D (MANAGEMENT - ETHICS - RESPONSIBILITY)	2.00
	HUM09-PM-E	C	Economics, Law and Business Studies E (International Strategy and Development)	2.00
	HUM09-PM-F	C	Economics, Law and Business Studies F (sustainable development)	2.00
	HUM09-PM-G	C	Economics, Law and Business Studies G (serious game)	2.00
	SGM09-CONF	O	Conférences	0.50

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

Microstructures of Materials	SGM09-MIMA
Number of hours : 20.00 h	2.00 ECTS credit
CM : 18.00 h, TP : 2.00 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	SGM09-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 :

COMPOSITES	SGM09-COMP
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : LE CORRE ALAIN	

Objectives :
This course is entirely in charge of external contributors, working as engineers in two different firms.

Goals
Introduction to composites : what is a composite ? What kind of use ? Which properties ? How are they manufactured ? Quality of products made off composites.

Content :
1st part (R . Tomasi ¿ CETIM Nantes)

- Introduction : matrix & resins_- Different varieties of matrix and resins_- Microstructures and properties adjustment_- Transformation process_- Quality controls
2d part (M. Kneveler ¿ IRT Jules Verne)

1) Explanation of the conception process for a piece or an assembly made off composite._- functional analysis of the part that need to be changed
- materials choices as a function of the stress (temperature, mechanical stress, etc.)_- introduction to the exchange rate concept_- choice of the manufacturing process_
2) Presentation of the aeronautic field_- history of composites in aeronautics_- which materials_- which consequences on the plane conception_- how is made an aileron

Bibliography :

Requirements :
Polymers, mechanichal properties of materials.

Organisation :

Evaluation :
Written exam. Duration : 1h.

Target :

Biomaterials	SGM09-BIO
Number of hours : 12.00 h	1.50 ECTS credit
CM : 9.00 h, CONF : 3.00 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	SGM09-MACC
Number of hours : 12.00 h	1.50 ECTS credit
CM : 6.00 h, TD : 6.00 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	SGM09-SCND
Number of hours : 28.00 h	1.50 ECTS credit
CM : 20.00 h, TP : 8.00 h	
Reference Teacher(s) : CORNEN MARILYNE	

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 Core Courses	SGM09-CIMA
Number of hours : 27.00 h	2.00 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.

Program 2014-2015 :

A. DPSS Lasers (6h) by Julien ROUVILLAIN, OXXIUS
1-Visible lasers
2-DPSS lasers
3-Oxxius products
4-DPSS Raman 588nm & 559nm
5-Uses of visible lasers

B. Introduction to composites (6h) by Richard TOMASI, CETIM Nantes
1-Definitions : bulks & resins
2-Various bulks and resins
3-Microstructures and properties adjustments
4-Transformation process
5-Quality vcontrol

C- Polymers materials in automotive (6h) by Alcina TANGHE, VALEO
1-Applications under engine hood
2-Failure analysis

Bibliography :

Requirements :
3SGM et 4SGM training

Organisation :

Evaluation :
Final mark /20. Based on the presence, no written exam.
1 unexcused absence = 15/20,
2 unexcused absences = 10/20,
3 unexcused absences = 0/20

Target :
Public
5SGM students

Elaboration and characterisation of nanostructures and Devices	SGM09-ECND
Number of hours : 14.00 h	2.00 ECTS credit
CM : 14.00 h	handout in English
Reference Teacher(s) : DURAND OLIVIER, LE CORRE ALAIN	

Objectives :
Epitaxial growth and characterisation of semiconductor heterostructures and electronic and optoelectronic devices.

Content :
Semiconductor epitaxy and applications.
Different growth technics (LPE, CVD, MOCVD, MBE, CBE...).
In-situ and ex-situ characterisation methods:
- RHEED, Refectance Anisotropy Spectroscopy.
- Optical, electrical and structural characterizations.
- Physico-chemical analysis (photoelectrons spectroscopy, Auger spectroscopy, Electron micro probe,SIMS....).
- Scanning probe method (Scanning tunnelling microscopy, STM, AFM...)
Growth of lattice matched and mismatched III-V heterostructures (elastic and plastic strain relaxation processes).
Growth of III-V nanostructures (multi-quantum well and superlattices, quantum wires and quantum dots).
Applications : Elaboration of device structures (Lasers, transistors, modulators and photodetectors).

Bibliography :
- M.A. Herman, H. SITTER, Molecular Beam Epitaxy; Springer-Verlag Berlin Heidelberg 1989.
- G.B. Stringfellow, Organoetallic Vapor Phase Epitaxy : Theory and Practice; Academic Press 1989.
- E. H. C. Parker "The Technology and Physics of Molecular Beam Epitaxy; Plenum Press New York 1985
- Jeffrey Y. Tsao "Materials fundamentals of molecular beam epitaxy"; Academic Press 1992.
- W.K. Liu et M.B. Santos "Thin Films: Heteroepitaxial Systems"; Series on Direction in Condensed Matter Physics
- Vol.15, World Scientific Publishing 1999
- John C. Vickerman, "Surface Analysis: The principle techniques"; ed ed. John Wiley et sons, Chichester, New York, 1997.

Requirements :
Properties of semiconductors (3rd and 4th year of the MNT course).

Organisation :
One hour for every hour of lecture time.

Evaluation :
Two-hour written examination.

Target :

Renewable Energy	SGM09-ENER
Number of hours : 12.00 h	1.50 ECTS credit
CM : 6.00 h, CONF : 6.00 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	SGM09-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	SGM09-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	SGM09-OPTO
Number of hours : 29.00 h	2.50 ECTS credit
CM : 14.00 h, TD : 15.00 h	
Reference Teacher(s) : LE CORRE ALAIN	

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	SGM09-ONL
Number of hours : 12.00 h	1.50 ECTS credit
CM : 12.00 h	course taught in English
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 :

Cas Industriels micro-optoélectronique	SGM09-CIMO
Number of hours : 27.00 h	2.00 ECTS credit
CM : 27.00 h	
Reference Teacher(s) : LETOUBLON ANTOINE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Advanced Materials Science	SGM09-MAVA
Number of hours : 15.00 h	2.00 ECTS credit
EP : 15.00 h	
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 :

Applications of lasers and photonics	SGM09-ALP
Number of hours : 15.00 h	2.00 ECTS credit
EP : 12.00 h	hand-out in English and course taught in English
Reference Teacher(s) : PERRIN MATHIEU	

Objectives :
Students have to study in pairs a particular subject related to applications of lasers and photonics. 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.

Content :
- Session 1: Several topics, in the broad area of lasers and their applications will be proposed for students to choose.
- Session 2 & 3: The class will meet twice in order to discuss projects advancement. Each team of two students should also meet and discuss their project more specifically with their tutor.
- Session 4: Final presentation of their research by each group.

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 :

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

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

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

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

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

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

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

Target :

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

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

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

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

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

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

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

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

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

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

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

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

Bibliography :
Given during the course

Requirements :
ECONOMICS AND BUSINESS MANAGEMENT - S7 and S8

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

Evaluation :
Continuous assessment (collective work)

Target :

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

Conférences	SGM09-CONF
Number of hours : 24.00 h	0.50 ECTS credit
CONF : 24.00 h, CONF : 24.00 h	
Reference Teacher(s) : LETOUBLON ANTOINE	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 10

Parcours Formation Initiale SGM

1	SGM10-PFE		Projet de Fin d'Etudes	30.00
	SGM10-PFE	O	Final Year Project	30.00

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

Final Year Project	SGM10-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 :