INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES

Academic year 2022/2023

Courses offered by the programme

Génie Mécanique et Automatique (GMA)
Mechanical and Control Systems Engineering

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

INSA Rennes - Génie Mécanique et Automatique (GMA) : 2022/2023 - Semester(s) : 5-6-7-8-9-10 - Sommaire

Code	Libelle
GMA08-MOROB	Robot Modelling
GMA08-PRCONS	Manufacturing & Design Project
GMA08-STAGE	4GMA Work Placement
GMA09-PI	Industrial project
GMA09-SYSME	Mechanical Systems
GMA09-VATR	Accuracy of Robots and Machine-tools
GMA10-PFE	Final Year Project

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

INSA RENNES - Génie Mécanique et Automatique (GMA) : 2022/2023

Semestre 5

Parcours Apprentissage

1	**GMA05-01-FISA**		**MECANIQUE & MATERIAUX FISA S5**	**6.00**
	GMA05-MMC FISA	O	Mécanique des milieux continus et Elasticité	2.00
	GMA05-MSI FISA	O	Mécanique des solides indéformables	2.00
	GMA05-MAT FISA	O	Matériaux	2.00
2	**GMA05-02-FISA**		**CONCEPTION & PROCEDES FISA S5**	**3.00**
	GMA05-PMI FISA	O	Procédés et méthodes d'industrialisation	2.00
	GMA05-ARSM FISA	O	Analyse et représentation des systèmes mécaniques	1.00
3	**GMA05-03-FISA**		**AUTOMATIQUE & MODELISATION FISA S5**	**4.00**
	GMA05-SIG FISA	O	Signaux et sytèmes	1.00
	GMA05-AURES FISA	O	Automates et réseaux locaux industriels	2.00
	GMA05-ANAL FISA	O	Maths	1.00
4	**GMA05-04-FISA**		**HUMANITES FISA S5**	**5.00**
	GMA05-ANGL FISA	O	Anglais FISA	2.00
	GMA05-RSDD FISA	O	Responsabilité Sociétale Développement Durable FISA	1.00
	GMA05-RISQ FISA	O	Risque FISA	1.00
	GMA05-EPS FISA	O	Education Physique et Sportive FISA	1.00
5	**GMA05-05-FISA**		**EXPERIENCE PROFESSIONNELLE FISA S5**	**12.00**
	GMA05-MISSI FISA	O	Mission Entreprise	10.00
	GMA05-PPS FISA	O	Parcours professionnel et Scolaire	2.00

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

Mécanique des milieux continus et Elasticité	GMA05-MMC FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 26.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mécanique des solides indéformables	GMA05-MSI FISA
Number of hours : 34.00 h	2.00 ECTS credit
TA : 4.00 h, TD : 18.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Matériaux	GMA05-MAT FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 18.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Procédés et méthodes d'industrialisation	GMA05-PMI FISA
Number of hours : 46.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 34.00 h, TP : 4.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Analyse et représentation des systèmes mécaniques	GMA05-ARSM FISA
Number of hours : 28.00 h	1.00 ECTS credit
TA : 6.00 h, TD : 22.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Signaux et sytèmes	GMA05-SIG FISA
Number of hours : 28.00 h	1.00 ECTS credit
TA : 6.00 h, TD : 22.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Automates et réseaux locaux industriels	GMA05-AURES FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 18.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Maths	GMA05-ANAL FISA
Number of hours : 20.00 h	1.00 ECTS credit
TA : 4.00 h, TD : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Anglais FISA	GMA05-ANGL FISA
Number of hours : 20.00 h	2.00 ECTS credit
TD : 0.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Responsabilité Sociétale Développement Durable FISA	GMA05-RSDD FISA
Number of hours : 20.00 h	1.00 ECTS credit
TD : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Risque FISA	GMA05-RISQ FISA
Number of hours : 24.00 h	1.00 ECTS credit
TD : 20.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Education Physique et Sportive FISA	GMA05-EPS FISA
Number of hours : 24.00 h	1.00 ECTS credit
TD : 24.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mission Entreprise	GMA05-MISSI FISA
Number of hours : 0.00 h	10.00 ECTS credit
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Parcours professionnel et Scolaire	GMA05-PPS FISA
Number of hours : 26.00 h	2.00 ECTS credit
TD : 26.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 5

Parcours Formation Initiale GMA

1	**GMA05-1**		**MECANIQUE & MATERIAUX S5**	**9.00**
	GMA05-MMC	O	Mech of Continuous and Deformable Media	3.00
	GMA05-MSI	O	Mécanique des solides indéformables	3.00
	ESM05-MAT	O	METALLIC MATERIALS	2.00
	GMA05-TPMAT	O	Metallurgy	1.00
2	**GMA05-2**		**CONCEPTION & PROCEDES S5**	**6.50**
	GMA05-PMI	O	Industrial Methods and Procedures	4.00
	GMA05-ARSM	O	Analyse et représentation des systèmes mécaniques	2.50
3	**GMA05-3**		**AUTOMATIQUE & MODELISATION S5**	**7.50**
	ESM05-SIG	O	Signals and Systems	2.00
	GMA05-AURES	O	Automatons and Local Industrial Networks	3.00
	ESM05-ANAL	O	Mathematical Analysis for the Engineer	1.50
	ESM05-MATLAB	O	Initiation Matlab	1.00
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-ELSA Thea**		**Theatre with studies**	**1.00**
	HUMF1-THEA	F	Study & Theater	1.00
10	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00
13	**HUMF1-SAMSTA2-4**		**Work Placement**	**4.00**
	EII05-STA2-4	F	2nd Year Work Placement	4.00
	GCU05-STA2-4	F	2nd Year Work Placement	4.00
	GMA05-STA2-4	F	2nd Year Work Placement	4.00
	INF05-STA2-4	F	2nd Year Work Placement	4.00
	ARO05-STA2-4	F	Stage 2ème année	4.00
14	**HUMF1-RIE**		**RIE : Recherche Innovation Entrepreneuriat**	**1.00**
	HUMF1- RI	F	Recherche Innovation	1.00
	HUMF1- IE	F	INNOVATION & ENTREPRENEURSHIP	1.00

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

Mech of Continuous and Deformable Media	GMA05-MMC
Number of hours : 42.00 h	3.00 ECTS credit
CM : 20.00 h, TD : 14.00 h, TP : 8.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
-Understanding the fundamental laws of deformable and continuous media.
-A modern presentation of the general concepts: (kinematics of deformations, laws of conservation and of reciprocal action).
-Classic applications of thermoelasiticity and stiffness of materials (In preparation for the "Résistance des Matériaux" module of the second semester).
-More complex models of the Thermomechanics of large deformations.

Content :
I Geometry of deformations.
II Dynamics.
III General laws of conservation.
VI Balance of energy and entropy.
V General laws of thermomechanical behaviour.
Detailed description: Geometry of deformations. Intuitive understanding of deformation. Transformation gradient. Convective
transport. Lagrangian and Eulerian tensors of dilation and deformation. Decomposition of displacements. Theories on
linearisation (theory of small deformations). Compatibility equations. Theory of small deformations.
Dynamics: Concept of the particular derivative of tensor and vector functions.
Particular derivatives of elements: linear, surface, volume. Particular derivatives of integrals. Introduction of the rate of
deformation in Lagrangian and Eulerian form. The exceptional case of isochoric movement. General laws of the conservation
of mass (in local and integral form). Introduction to the kinetic and dynamic principles of torque. Fundamental laws of
dynamics. Existence of the Cauchy stress tensor. Consequences of the laws of reciprocal movement and of the moment of the
quantity of movement. Tensor of Lagrangian stress. Theory of kinetic energy. Concept of virtual power.
Accounting for energy and entropy: Integral and local form of the first law of thermodynamics. Balance. Concept of deformation energy.
Second law of thermodynamics: Localised form. Concept of dissipation. General laws of thermomechanical behaviour.
Classing of unknowns. Use of the second principle. Laws governing state of matter. The Gibbs relation and the transformation
of Legendre and Frenchel. Introduction of dissipation. Examples: hyperelastic environments, linear thermoelasticity.

Bibliography :
Jean COIRIER : Mécanique des Milieux Continus - Concepts de base. DUNOD (1997).
Georges DUVAUT : Mécanique des Milieux Continus. DUNOD (1998).
Paul GERMAIN : Cours de Mécanique des Milieux Continus. MASSON (1973).
D.S. DUGDALE et C. RUIZ : Elasticité à l'usage des Ingénieurs et Physiciens. Edisciences (1973).

Requirements :
Mathematics: Analysis (vector mathematics, application of particular derivatives, Concepts of tensor calculation, etc).
Other disciplines: General knowledge of Mechanics and Plane Elasticity.

Organisation :

Evaluation :
Three-hour written examination. Practical work.

Target :

Mécanique des solides indéformables	GMA05-MSI
Number of hours : 34.00 h	3.00 ECTS credit
TD : 22.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

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 :

Metallurgy	GMA05-TPMAT
Number of hours : 16.00 h	1.00 ECTS credit
TP : 16.00 h	
Reference Teacher(s) :	

Objectives :
In depth look at the relationship between microstructure and properties in the common alloy families.
Understanding diffusion
mechanisms.

Content :
I. DIFFUSION IN SOLIDS:
1. Flick's law, Diffusion equation and solutions for simple cases.
2. Diffusion coefficient. the problems of diffusion: carburation, evaporation. Arrhenius's Law.
3. Diffusion: carburetion, evaporation.
II. PHASE TRANSFORMATIONS:
1. Solidification: the influence of conditions on properties (germination, separation, unbalanced phases.)
2. Solubility limits and precipitation: Coherent and Incoherent Precipitates. Inter and intragranular preciptation. Effect on properties. Examples of stainless steel and of alloys with structural or precipitate hardening.
3. Martensitic and Baintic transformations and their applications to the shape memory of alloys and steel.
III. THERMAL TREATMENT:
Influence on mechanical properties. Examples from the family of steel alloys, aluminium alloys, copper alloys and titanium
alloys.
1. Reheating for homogenisation, dissolution of precipitations.
2. Restoration-recrystallisation after work-hardening.
3. quenching, quenching and return (structural hardening). Comparison between the structural hardening of steels and alloys.
4. Superficial martenisitic quenching and superficial thermal treatments.
IV. GEOMETRICAL CRYSTALLOGRAPHY:
1. Crystal networks, knots, nets and motifs. Miller indices, reciprocal network.
2. Metals and crystal structures. Cubic and hexagonal structures. Understanding schematics and compact directions. Sliding mechanisms.
V. USE OF X-RAYS in the characterisation of materials:
1. X-ray generation, application of chemical material analysis to emmision spectrometry (electronic micro-sensor).
2. Absorption: application of radiography (detection of flaws), for qualitative and quantitative analysis.
3. Fluouresence: definition, use and material analysis
4. Diff ratio: a basic approach to a characterisation of crystal structures. Practical work: (4 Practical Work Sessionss of 4 hours each) - metallography - thermal analysis (ATS- ATD) - Jominy's test on two steel samples. Structural hardening on (aluminium and copper).

Bibliography :
C.S. BARRETT, Structure des Métaux, Dunod, Paris (1957).
TAYLOR, X-Ray Metallography, J. Wiley and Sons Inc., New-York, London (1961)
J.P. EBERHART, Analyse structurale et chimique des matériaux, Dunod , Paris (1997).
A. DE SY, J. VIDTS, Traité de métallurgie structurale théorique et appliquée, Dunod, Paris (1968).
J. PHILIBERT, A. VIGNES, Y. BRECHET, P. COMBRADE, Métallurgie du minerai au matériau, Masson, Paris (1997) J. BARRALIS, G MAEDER, Précis de métallurgie, Elaboration, structures, propriétés, AFNOR-NATHAN(1997)
Y.ADDA, J. PHILIBERT, La diffusion dans les solides, INSTN (1966)

Requirements :
Global understanding of phase diagrams. Preferably a prespecialisation course in materials.

Organisation :

Evaluation :
Three-hour written examination. Mark for practical work.

Target :

Industrial Methods and Procedures	GMA05-PMI
Number of hours : 42.00 h	4.00 ECTS credit
CM : 20.00 h, TD : 22.00 h	
Reference Teacher(s) : SORRE Frederic	

Objectives :
This module aims to equip the future engineer with a knowledge of industrial methods and procedures in order to successfully
integrate the workplace and to communicate and interact with new colleagues and collaborators.

Content :
(I) Methodology: Geometrical errors in products (dimension, position, form, surface condition). Specification of the geometry
of products (Interpretation and verification). Geometrically identifying a surface. Isostatism (rules and symbology). Fabrication
documents. Vector models of machines (basing milling centres SMED). Architecture of computer-controlled machines.
(II) Proceses: Moulding techniques. Forging techniques. Pressing metals. Milling and turning techniques (geometry, materials,
tool wear, parameters). Means of measuring and checking geometric specifications.

Bibliography :

Requirements :

Organisation :

Evaluation :
Three-hour written examination.

Target :

Analyse et représentation des systèmes mécaniques	GMA05-ARSM
Number of hours : 28.00 h	2.50 ECTS credit
TD : 28.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

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.

Automatons and Local Industrial Networks	GMA05-AURES
Number of hours : 42.00 h	3.00 ECTS credit
CM : 16.00 h, TD : 10.00 h, TP : 16.00 h	
Reference Teacher(s) : MAURINE Patrick	

Objectives :
Creation of sequentially commanded automatic production systems using appropriate tools. Industrial networks and
automatons.

Content :
1. Synthesis and optimisation of sequential logic systems. Mealy and Moore machines. Representing sequential systems.
Flipflops. Synthesis of synchronised sequential systems. The Huffman-Mealy method.
2. Industrial Programmable machines (IPM): Placement and role of an IPM at the core of an automated industrial production
system. Specific structure and functionality of an IPM. Connection and peripherals of the automaton. IPM programming
languages. Connection to networks.
3. Grafcet: Definitions and normalisation. Basic elements; Syntax and evolution of the system. Basic and special structures.
Extension of the representations. Marco-stages using Grafcet. Algorithms and equivalent equations. Partition and placement of
a Grafcet. Forcing situations.
4. Local industrial systems: Functional architecture of local industrial networks. SIM and three-axis modelling. Field networks.
Architecture, reduced OSI model. FIP, ASI and PROBUS networks.

Bibliography :
1. GREPA, "" Le Grafcet "", 2ème édition, 1995, Cépadues 2. CIAME, "" Réseaux de terrain "", 1998, Hermès

Requirements :
1. Combinational logic.
2. Study and optimisation of combinational logic systems.

Organisation :

Evaluation :
Two-hour examination. Mark for practical work.

Target :

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 :

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 :

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

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

2nd Year Work Placement	EII05-STA2-4
Number of hours : 240.00 h	4.00 ECTS credit
DIV : 0.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

2nd Year Work Placement	GCU05-STA2-4
Number of hours : 240.00 h	4.00 ECTS credit
CONF : 0.00 h, DIV : 0.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

2nd Year Work Placement	GMA05-STA2-4
Number of hours : 240.00 h	4.00 ECTS credit
DIV : 0.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

2nd Year Work Placement	INF05-STA2-4
Number of hours : 240.00 h	4.00 ECTS credit
DIV : 0.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Stage 2ème année	ARO05-STA2-4
Number of hours : 240.00 h	4.00 ECTS credit
DIV : 0.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

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 :

Semestre 6

Parcours Apprentissage

1	**GMA06-01-FISA**		**MECANIQUE & MATERIAUX FISA S6**	**6.00**
	GMA06-CDM FISA	O	Cinématique et dynamique des mécanismes	2.00
	GMA06-MDF FISA	O	Mécanique des fluides	2.00
	GMA06-RDM FISA	O	Résistance des matériaux	2.00
2	**GMA06-02-FISA**		**CONCEPTION & PROCEDES FISA S6**	**3.00**
	GMA06-DICM FISA	O	Dimensionnement et intégration des composants mécaniques	1.00
	GMA06-MOPI FISA	O	Mise en oeuvre des procédes d'industrialisation	2.00
3	**GMA06-03-FISA**		**AUTOMATIQUE & MODELISATION FISA S6**	**3.00**
	GMA06-AUT FISA	O	Automatique I	2.00
	GMA06-MSMD FISA	O	Modélisation des systèmes mécaniques discrets	1.00
4	**GMA06-04-FISA**		**HUMANITES FISA S6**	**5.00**
	GMA06-ANGL FISA	O	Anglais	2.00
	GMA06-AMEL FISA	O	Gestion de Production et Amélioration continue	1.00
	GMA06-COMPT FISA	O	Comptabilité Finance Contr^ole de Gestion	1.00
	GMA06-EPS FISA	O	Education Physique et Sportive	1.00
5	**GMA06-05-FISA**		**EXPERIENCE PROFESSIONNELLE FISA S6**	**12.00**
	GMA06-MISSI FISA	O	Mission Entreprise	10.00
	GMA06-PPS FISA	O	Parcours professionnel et Scolaire	2.00

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

Cinématique et dynamique des mécanismes	GMA06-CDM FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TA : 8.00 h, TD : 18.00 h, TD : 18.00 h, TP : 16.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mécanique des fluides	GMA06-MDF FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TA : 8.00 h, TD : 22.00 h, TD : 22.00 h, TP : 12.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Résistance des matériaux	GMA06-RDM FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TA : 8.00 h, TD : 22.00 h, TD : 22.00 h, TP : 12.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Dimensionnement et intégration des composants mécaniques	GMA06-DICM FISA
Number of hours : 28.00 h	1.00 ECTS credit
TA : 6.00 h, TD : 22.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mise en oeuvre des procédes d'industrialisation	GMA06-MOPI FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 18.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Automatique I	GMA06-AUT FISA
Number of hours : 40.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 20.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Modélisation des systèmes mécaniques discrets	GMA06-MSMD FISA
Number of hours : 24.00 h	1.00 ECTS credit
TA : 2.00 h, TD : 14.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Anglais	GMA06-ANGL FISA
Number of hours : 22.00 h	2.00 ECTS credit
TD : 22.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Gestion de Production et Amélioration continue	GMA06-AMEL FISA
Number of hours : 24.00 h	1.00 ECTS credit
TA : 4.00 h, TD : 20.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Comptabilité Finance Contr^ole de Gestion	GMA06-COMPT FISA
Number of hours : 24.00 h	1.00 ECTS credit
TA : 4.00 h, TD : 20.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Education Physique et Sportive	GMA06-EPS FISA
Number of hours : 20.00 h	1.00 ECTS credit
TD : 20.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mission Entreprise	GMA06-MISSI FISA
Number of hours : 0.00 h	10.00 ECTS credit
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Parcours professionnel et Scolaire	GMA06-PPS FISA
Number of hours : 6.00 h	2.00 ECTS credit
TD : 6.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 6

Parcours Formation Initiale GMA

1	**GMA06-1**		**MECANIQUE & MATERIAUX S6**	**9.00**
	GMA06-CDM	O	Kinematics and Dynamics of Mechanisms	3.50
	GMA06-MDF	O	Mécanique des fluides	3.00
	GMA06-RDM	O	Resistance of Materials	4.00
2	**GMA06-2**		**CONCEPTION & PROCEDES S6**	**7.00**
	GMA06-DICM	O	Dimensionnement et intégration des composants mécaniques	2.00
	GMA06-PCO	O	Projet de conception	2.00
	GMA06-MOPI	O	Industrial Methods and Processes	3.00
3	**GMA06-3**		**AUTOMATIQUE & MODELISATION S6**	**7.00**
	ESM06-AUTO	O	Control Systems Engineering	3.00
	GMA06-MSMD	O	Modélisation des systèmes mécaniques discrets	1.00
	GMA06-EDP	O	Partial Differential Equations	2.00
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

Kinematics and Dynamics of Mechanisms	GMA06-CDM
Number of hours : 42.00 h	3.50 ECTS credit
CM : 16.00 h, TD : 10.00 h, TP : 16.00 h	
Reference Teacher(s) : ARAKELYAN Vigen	

Objectives :
Systematic approach to methods and general principles of the study of mechanisms. Calculation of mechanical systems from
given conditions.

Content :
Kinematics and Dynamics of mechanisms
- Structural analysis of mechanisms
- Analysis of the singular positions of mechanisms
- Mechanisms with specific structures (Bennett mechanism, 3D spherical mechanisms with 4 rods, Sarrus mechanism). Kinematic analysis of 3D mechanisms. Method for transformation of coordinates: "Denavit-Hartenberg" method
- Kinematic analysis of closed-chain mechanisms. Cam mechanisms: main laws of motion with their typical characteristics
- Example of a cam fairing with an elastic receptor. Kinematics of articulated mechanisms with gears. Watt mechanism.
- Geometric synthesis of mechanisms. Burmister problem. Synthesis of a polyarticulated mechanism, function generator for
three, four, and five given positions (polynomial method)
- Rough reproduction of a given motion (approximation by quadratic mean-value and the minimisation of the maximum value: Chébichev approximation)
- Synthesis of mechanisms under futher conditions (transmission angle, etc.)
- Newton-Euler equation
- D'Alembert rule and calculation of stress in mechanical bonds: matrix method. Assur groups: Calculation simplification by reduced size matrix.
- Lagrange equation. Examples of industrial systems and applications.
- Equation of motion of single degree of freedom mechanisms (simplified form of the Lagrange equation).
- Momentum: calculation and minimisation. Relief system of elements of a mechanism.

Bibliography :

Requirements :
Linear mapping, matrixes, differential equations, approximation methods (VMQ, Thcebichev, etc).

Organisation :

Evaluation :
Two-hour written examination.
Mark for practical work in the laboratory.

Target :

Mécanique des fluides	GMA06-MDF
Number of hours : 42.00 h	3.00 ECTS credit
CM : 16.00 h, TD : 14.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Resistance of Materials	GMA06-RDM
Number of hours : 56.00 h	4.00 ECTS credit
CM : 22.00 h, TD : 22.00 h, TP : 12.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
This module is a more pragmatic extension of the "Continuum Mechanics" module of semester 5, including simplification of
the classic Beam Theory and experimental basics in Resistance of Materials leading to familiarisation with the basic tools
necessary in Mechanics for the calculation and design of parts.

Content :
Theory of Elasticity as applied to beams in 3D (Reminder). Beam Theory (fundamental hypothesis). Strain and deformation
due to normal stress and bending moments (pure flexion, simple flexion, composed flexion, deviated flexion, etc). Strain and
deformation due to the cutting stress (full cross-section, slim cross-section: shearing flux, torsion centre, etc). General
theorems for the calculation of displacement and rotation of mean-plane beams (application of the Energy Theorems seen in
Continuum Mechanics, NAVIER-BRESSE's equation). General methods to solve hyperstatic beam systems. Isostatic straight
beams. Hyperstatic straight beams with one span.

Bibliography :
M. KERGUIGNAS, G. CAIGNAERT : Résistance des Matériaux. DUNOD (1997).
M. ALBIGES : Résistance des Matériaux Appliquée. DUNOD.
J. COURBON : Résistance des Matériaux. DUNOD (1971).

Requirements :
General Mechanics and Continuum Mechanics

Organisation :

Evaluation :
Three-hour written examination.
Mark for practical work in the laboratory

Target :

Dimensionnement et intégration des composants mécaniques	GMA06-DICM
Number of hours : 28.00 h	2.00 ECTS credit
TD : 28.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Projet de conception	GMA06-PCO
Number of hours : 24.00 h	2.00 ECTS credit
TP : 24.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Industrial Methods and Processes	GMA06-MOPI
Number of hours : 42.00 h	3.00 ECTS credit
CM : 12.00 h, TD : 14.00 h, TP : 16.00 h	
Reference Teacher(s) : SOHIER Christophe	

Objectives :
Experimental and practical implementation of industrial processes and methods requires good technical skills. The issues of
quality, performance and production costs are highlighted.

Content :
I- Methods: Process dimensioning. Product range. Modelling of the faults in the manufacturing process. Tool design.
Machining of warped shapes.
II- Processes: Specific manufacturing techniques (spark-machining, water jet cutting). Fast prototyping. Welding techniques.

Bibliography :

Requirements :
Industrial processes and methods.

Organisation :
10 hours.

Evaluation :
Three-hour written examination.
Mark for practical work.

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 :

Modélisation des systèmes mécaniques discrets	GMA06-MSMD
Number of hours : 24.00 h	1.00 ECTS credit
CM : 4.00 h, TD : 12.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Partial Differential Equations	GMA06-EDP
Number of hours : 28.00 h	2.00 ECTS credit
CM : 14.00 h, TD : 14.00 h	
Reference Teacher(s) : LEY Olivier	

Objectives :
The main types of partial differential equations from physical models. Introduction to exact and approximate solution methods.

Content :
1. Basic laws of conservation in single dimension: Study of the equation of advection.
2. Systems of laws of conservation: Motion of a fluid in a tube. Study of the wave equation in one dimension.
3. Phenomenon of diffusion: Fourier type equation. Resolution method by Fourier analysis.
4. Stationary problems: Poisson-type equations. Simple examples of numerical methods.

Bibliography :
"Partial Differential Equations - Modeling, Analysis, Computation"
R.M. MATTHEIJ, S.W. RIENSTRA, J.H. TEN THIJE
BLOONKKAMP, SIAM Monographs on Math. Modelling (2005)

Requirements :
Systems of differential equations.
- Elementary analysis of functions of multiple variables.
- Fourier's series.

Organisation :
12 hours.

Evaluation :
Two-hour written examination.

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 Apprentissage

1	**GMA07-1 FISA**		**MECANIQUE & MATERIAUX FISA S7**	**4.00**
	GMA07-MNEF FISA	O	Méthodes numériques et éléments finis	2.00
	GMA07-RDM2 FISA	O	RDM2:Torsion & Calcul de structures	2.00
2	**GMA07-2 FISA**		**CONCEPTION & PROCEDES FISA S7**	**4.00**
	GMA07-CMAO2 FISA	O	Conception mécanique assistée par ordinateur 2	2.00
	GMA07-PUIS FISA	O	Transmission de puissance	2.00
3	**GMA07-3 FISA**		**AUTOMATIQUE & MODELISATION FISA S7**	**3.00**
	GMA07-AUTO2 FISA	O	Automatique 2	2.00
	GMA07-EEP FISA	O	Electrotechnique et électronique de puissance	1.00
4	**GMA07-4 FISA**		**INDUSTRIALISATION FISA S7**	**2.00**
	GMA07-PRIND FISA	O	Projet d'industrialisation	2.00
5	**GMA07-5 FISA**		**HUMANITES FISA S7**	**6.00**
	GMA07-ANGL FISA	O	Anglais	2.00
	GMA07-EPS FISA	O	Education Physique et Sportive	1.00
	GMA07-DROIT FISA	O	Droit	2.00
	GMA07-EI FISA	O	Entreprendre et Innover	1.00
6	**GMA07-6 FISA**		**EXPERIENCE PROFESSIONNELLE FISA S7**	**11.00**
	GMA07-MISSI FISA	O	Mission Entreprise	10.00
	GMA07-PPS FISA	O	Parcours Professionnel et Scolaire	1.00

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

Méthodes numériques et éléments finis	GMA07-MNEF FISA
Number of hours : 8.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 34.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

RDM2:Torsion & Calcul de structures	GMA07-RDM2 FISA
Number of hours : 50.00 h	2.00 ECTS credit
TA : 10.00 h, TD : 28.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Conception mécanique assistée par ordinateur 2	GMA07-CMAO2 FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 22.00 h, TP : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Transmission de puissance	GMA07-PUIS FISA
Number of hours : 56.00 h	2.00 ECTS credit
TA : 10.00 h, TD : 30.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Automatique 2	GMA07-AUTO2 FISA
Number of hours : 56.00 h	2.00 ECTS credit
TA : 10.00 h, TD : 30.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Electrotechnique et électronique de puissance	GMA07-EEP FISA
Number of hours : 36.00 h	1.00 ECTS credit
TA : 8.00 h, TD : 20.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Projet d'industrialisation	GMA07-PRIND FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 14.00 h, TP : 20.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Anglais	GMA07-ANGL FISA
Number of hours : 26.00 h	2.00 ECTS credit
TA : 4.00 h, TD : 22.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Education Physique et Sportive	GMA07-EPS FISA
Number of hours : 24.00 h	1.00 ECTS credit
TD : 24.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Droit	GMA07-DROIT FISA
Number of hours : 14.00 h	2.00 ECTS credit
TD : 12.00 h, TP : 2.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Entreprendre et Innover	GMA07-EI FISA
Number of hours : 48.00 h	1.00 ECTS credit
TA : 8.00 h, TD : 40.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mission Entreprise	GMA07-MISSI FISA
Number of hours : 10.00 h	10.00 ECTS credit
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Parcours Professionnel et Scolaire	GMA07-PPS FISA
Number of hours : 14.00 h	1.00 ECTS credit
TD : 14.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 7

Parcours Formation Initiale GMA

1	**GMA07-1**		**Mechanical Engineering and Materials S7**	**7.00**
	GMA07-MNEF	O	Numerical Methods and Finite Elements	3.00
	GMA07-RDM2	O	Resistance of Materials 2	4.00
2	**GMA07-2**		**Design and Processes S7**	**7.00**
	GMA07-CMAO2	O	Computer - aided Mechanical Design (Level 2)	3.00
	GMA07-PUIS	O	Mechanical Behaviour of Materials	4.00
3	**GMA07-3**		**Automation and Model-Building S7**	**6.00**
	GMA07-AUTO2	O	Control System Engineering 2	4.00
	GMA07-EEP	O	Electrical and Electronics Engineering	2.00
4	**GMA07-4**		**Industrialization Project**	**4.00**
	GMA07-PRIND	O	Project: Industrialisation	4.00
5	**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
9	**HUMF1-ELSA Thea**		**Theatre with studies**	**1.00**
	HUMF1-THEA	F	Study & Theater	1.00
10	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00

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

Numerical Methods and Finite Elements	GMA07-MNEF
Number of hours : 42.00 h	3.00 ECTS credit
CM : 20.00 h, TD : 22.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
Understanding the methods and algorithms involved in finite element calculation code. Basics of F.E.M. in order to fully
understand calculation software. Application of the methods to solve various field problems in deformable Solid Mechanics
and Heat Transfer. Application of the various formulas to practical problems using CAST3M software.

Content :
Introduction: Main points. Understanding the basic tools of numerical analysis: Interpolation, Approximation. Numerical
resolution of systems of linear equations. Numerical integration techniques. Partial differential equations. Boundary problems:
Finite Elements Methods. Variational formulation of a boundary (Reminder). Matrix formulation of the method in plane
elasticity. Interpolation function of plane elements. Generalisation to 3D. Curved isoparametric elements. Problems associated
with numerical integration. Specific elements: beams, thin plates, thick plates, shells. Extension of the method to heat transfer
problems.

Bibliography :
Zienkiewicz : La méthode des Eléments finis. Edisciences Gallagher : Introduction au calcul par Eléments Finis. Editions
Pluralis Batoz, Dhatt : Modélisation des structures par éléments finis. Editions Hermès
K. J. Bathe : Finite Element Procedures in Engineering Analysis. Prentice et Hall

Requirements :
Basics of Continuum Mechanics.

Organisation :
2 hours per week.

Evaluation :
Three-hour written examination at the end of the semester.
Continuous assessment mark.

Target :

Resistance of Materials 2	GMA07-RDM2
Number of hours : 56.00 h	4.00 ECTS credit
CM : 22.00 h, TD : 22.00 h, TP : 12.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
A continuation of the RDM I module of the third year of studies. This module deals with the dimensioning of beams under
torsion, the study of systems of beams and the modelling of plates.

Content :
Torsion: Theory of Saint Venant Torsion. General theory. Bredt's theory (thin-walled closed sections). Analogy of a membrane. Non-uniform torsion. Vlassov's theory (small distortion). General theorem for the calculation of displacement and
rotation of beams in a common plane. Application of the energy theorems from the "mechanics of continuous media" module.
NAVIER-BRESSE equations. General equations for solving hyperstatic beams and beam systems. Treillis. Porticos. Arcs and
systems of beams. Plate theory. Thin plates. Kirchhoff's theory. Thick plates. Mindlin's theory.

Bibliography :
M. KERGUIGNAS, G. CAIGNAERT : Résistance des Matériaux. DUNOD (1997).
M. ALBIGES : Résistance des Matériaux Appliquée.
DUNOD.
J. COURBON : Résistance des Matériaux. DUNOD (1971).

Requirements :
Basics of mechanics of continuous media.

Organisation :
Two hours per week.

Evaluation :
Three-hour written examination at the end of the semester.
Mark for practical work reports.

Target :

Computer - aided Mechanical Design (Level 2)	GMA07-CMAO2
Number of hours : 42.00 h	3.00 ECTS credit
CM : 10.00 h, TD : 20.00 h, TP : 12.00 h	
Reference Teacher(s) : LEOTOING Lionel	

Objectives :
- Methods for functional specifications and technical solutions for product functionality
- Advanced Design methods using CATIA
- Virtual evaluation of the adequacy of the product with respect to its specifications
- The principles of PLM.

Content :
1 - Methods of design (AFB, AFT)
2 - Advanced design with CATIA V5 (Design with context, power copies, publications, ...)
3 - Virtual conformity with the product specifications (simulation tools, exchange formats, ...)
4 - Creating geometrically optimal systems
5 - Introduction to PLM

Bibliography :

Requirements :
GMA06-CMAO1

Organisation :
1 hour per week.

Evaluation :
- 1 four-hour written examination on the Catia computer programme
- 1 mark for practical work

Target :

Mechanical Behaviour of Materials	GMA07-PUIS
Number of hours : 56.00 h	4.00 ECTS credit
CM : 16.00 h, TD : 24.00 h, TP : 16.00 h	
Reference Teacher(s) : GUINES Dominique	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :
45h

Evaluation :
Three-hour written examination at the end of the semester
Evaluation of the practical work reports

Target :

Control System Engineering 2	GMA07-AUTO2
Number of hours : 56.00 h	4.00 ECTS credit
CM : 22.00 h, TD : 18.00 h, TP : 16.00 h	
Reference Teacher(s) : LE BRETON Ronan	

Objectives :
-The concept of State for the modelling of dynamic systems.
-Solutions to state equations.
-Study of controllability, stability and operability of systems.
-Digital or analog command of multivariable dynamic systems.
-Synthesis of means of control by returning to a reconstructed state.

Content :
Analysis of dynamic systems in State-space. Models of State: the concept of State, conversion State - transfer, conversion
Transfer.
- State, Equivalence of models of State.
- Resolution of State equations - own functions of free systems, symbolic or numerical calculation of the transition matrix,
numerical integration of State equations, discrete state equations of pulsed systems (zero order blockers and ideal pulsed
systems). Stability of systems: Stability with respect to initial conditions..
- Stability for limited input.
- Limited output, stability of linear invariant systems.
- Control and observation: Canonical decomposition into controllable and observable subsystems.

Bibliography :
JAUME D., 1989, « Applications du formalisme d'état à la commande des systèmes continus », Eyrolles.
JAUME D., THELLIEZ S., VERGE M., 1991, « Commande des systèmes dynamiques par calculateur », Eyrolles.
KUO Benjamin C., 1995, « Automatic control systems », Prentice Hall International Editions.
DE LARMINAT Ph., 1993, « Automatique, commande des systèmes linéaires », Hermès.
GILLE J.-C., CLIQUE M., 1990, « Systèmes linéaires - Equations d'état », Eyrolles.

Requirements :
GMA05 SISYS -GMA05 AUT1

Organisation :
Revision of lecture notes. Preparation of exercises, problems and practical work (Three hours per week).

Evaluation :
Three-hour written examination at the end of the semester.
Mark for practical work report.

Target :

Electrical and Electronics Engineering	GMA07-EEP
Number of hours : 36.00 h	2.00 ECTS credit
CM : 14.00 h, TD : 14.00 h, TP : 8.00 h	
Reference Teacher(s) : GUEGAN Sylvain	

Objectives :
Fundamentals of electrotechnics in order to understand the functionality, energy supply, modelling and controls of electric
machines.

Content :
-Single-phase and three-phase circuits: Analysis methods. Real power and reactive power. Measurement of power.
-Magnetic circuits and inductance: Electromagnetism (Reminder). Magnetic circuit. Inductance and coupled circuits.
-Transformers: Single-phase and three-phase power transformers.
-Conversion of electric energy: Principles of the conversion of electric energy. Power components: diode, thyristor, bipolar
transistor, MOSFET, IGBT. Basic converter circuits: AC-DC, DC-DC, DC-AC, AC-AC. Applications.
-Electric machines: Principles (Reminder). Introduction of various types of machines (applications and trends). Main points on
the making and dimensioning of machines and materials used. Equilibrium and stability of a force. Characteristics of
couple-velocity of common driven loads. Characteristics and limits.

Bibliography :
R. MERAT et al., ""Génie électrotechnique"", Etapes références, Nathan, 1997.
G. GRELLET, G. CLERC, ""Actionneurs électriques : principes - modéles - commandes"", Eyrolles, 2000.
M. MARTY, D. DIXNEUF, D. GARCIA GILABERT,
""Principes d'électrotechnique"", Sciences Sup, Dunod, 2005.

Requirements :
Basics in electrotechnics and electromagnetism.

Organisation :
30 hours.

Evaluation :
2-hour written examination.
Continuous evaluation.

Target :
4GMA

Project: Industrialisation	GMA07-PRIND
Number of hours : 42.00 h	4.00 ECTS credit
CM : 2.00 h, TD : 20.00 h, TP : 20.00 h	
Reference Teacher(s) : SOHIER Christophe	

Objectives :
This is a proactive project in which the student plays a fundamental role calling upon previously acquired knowledge while
developing new technical and organisational skills. The aim of this module is to present the student with the following
objectives: Find solutions to technical procedural issues. Establish a clear overview of the process. Make necessary
adjustments to production tools.

Content :
From product specifications, set out the various manufacturing phases including design. Establishment of the manufacturing
process and the production phase. Subdividing the process into three steps allows the clear identification of the relationships
and constraints between the various phases and resources. The financial constraints are established through a cost estimate and
form an important part of the approach to the project.

Bibliography :

Requirements :
GMA05-PMI and GMA06-MOPI

Organisation :
20 hours.

Evaluation :
Manufacturing report.
Oral presentation.

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 :

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

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 Apprentissage

1	**GMA08-1 FISA**		**MECANIQUE & MATERIAUX FISA S8**	**5.00**
	GMA08-CMAT FISA	O	Comportement mécanique des matériaux	3.00
	GMA08-COMP FISA	O	Mécanique des matériaux composites	2.00
2	**GMA08-2 FISA**		**CONCEPTION & PROCEDES FISA S8**	**5.00**
	GMA08-PRCONS FISA	O	Projet de construction	3.00
	GMA08-PROD FISA	O	Productique & Qualité	2.00
3	**GMA08-3 FISA**		**AUTOMATIQUE & MODELISATION FISA S8**	**2.00**
	GMA08-MOROB FISA	O	Modélisation des robots	2.00
4	**GMA08-4 FISA**		**HUMANITES FISA S8**	**4.00**
	GMA08-ANGL FISA	O	Anglais	2.00
	GMA08-EPS FISA	O	EPS	1.00
	GMA08-GP FISA	O	Gestion de projet	1.00
5	**GMA08-5 FISA**		**EXPERIENCE PROFESSIONNELLE FISA S8**	**14.00**
	GMA08-MISSI FISA	O	Mission en Entreprise	13.00
	GMA08-PPS FISA	O	Parcours Professionnel et Scolaire	1.00

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

Comportement mécanique des matériaux	GMA08-CMAT FISA
Number of hours : 56.00 h	3.00 ECTS credit
TA : 10.00 h, TD : 38.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mécanique des matériaux composites	GMA08-COMP FISA
Number of hours : 28.00 h	2.00 ECTS credit
TA : 6.00 h, TD : 14.00 h, TP : 8.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Projet de construction	GMA08-PRCONS FISA
Number of hours : 44.00 h	3.00 ECTS credit
TA : 8.00 h, TD : 2.00 h, TP : 34.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Productique & Qualité	GMA08-PROD FISA
Number of hours : 28.00 h	2.00 ECTS credit
TA : 6.00 h, TD : 18.00 h, TP : 4.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Modélisation des robots	GMA08-MOROB FISA
Number of hours : 42.00 h	2.00 ECTS credit
TA : 8.00 h, TD : 18.00 h, TP : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Anglais	GMA08-ANGL FISA
Number of hours : 24.00 h	2.00 ECTS credit
TA : 4.00 h, TD : 20.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

EPS	GMA08-EPS FISA
Number of hours : 16.00 h	1.00 ECTS credit
TD : 16.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Gestion de projet	GMA08-GP FISA
Number of hours : 14.00 h	1.00 ECTS credit
TD : 14.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mission en Entreprise	GMA08-MISSI FISA
Number of hours : 13.00 h	13.00 ECTS credit
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Parcours Professionnel et Scolaire	GMA08-PPS FISA
Number of hours : 1.00 h	1.00 ECTS credit
TD : 6.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Semestre 8

Parcours Formation Initiale GMA

1	**GMA08-1**		**Mechanical Engineering and Materials S8**	**6.00**
	GMA08-CMAT	O	Mechanical Behaviour of Materials	4.00
	GMA08-COMP	O	Mechanics of Composite Materials	2.00
2	**GMA08-2**		**Design and Processes S8**	**7.00**
	GMA08-PRCONS	O	Manufacturing & Design Project	4.00
	GMA08-PROD	O	Production and Quality Control Management	3.00
3	**GMA08-3**		**Automation and Model-Building S8**	**3.00**
	GMA08-MOROB	O	Robot Modelling	3.00
4	**GMA08-STAGE**		**Work placement S8**	**8.00**
	GMA08-STAGE	O	4GMA 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	**HUMF2-ELSA Mus**		**Music with Studies**	**1.00**
	HUMF2-MUS	C	Music Studies	1.00

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

Mechanical Behaviour of Materials	GMA08-CMAT
Number of hours : 56.00 h	4.00 ECTS credit
CM : 26.00 h, TD : 22.00 h, TP : 8.00 h	
Reference Teacher(s) : GUINES Dominique	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Mechanics of Composite Materials	GMA08-COMP
Number of hours : 28.00 h	2.00 ECTS credit
CM : 12.00 h, TD : 8.00 h, TP : 8.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
The design of structural elements made of composite materials.
Part One: Mathematical formulas for the thermo-mechanical behaviour of composite materials (anisotropy, homogenisation, rupture criteria) leading to the dimensioning of composite cross-sections (beams or plates).
Part Two: Implementation and manufacturing technologies.

Content :
Part One: Introduction. Formulas for the behaviour of an anisotropic elastic media (Reminders). Full anisotropy. Orthotropy.
Transversal isotropy. Mechanical formulation of the rupture criteria in anisotropic materials. Hill-Tsaï's criterion. Wu's
criterion. Homogenisation techniques. thermoelastic constants of a unidirectional composite. Thermoelastic behaviour of a
layer in any direction. Matrix formulas for the behaviour of a laminate. Predimensioning and checking of the laminate in
comparison with the rupture criterion.
Part Two: General introduction. General definition of a composite material, reinforcements, matrices. semi-finished products.
Manufacturing procedures. Casting without press. Casting under pressure. Continuous transformation. Manufacturing of
revolution's form. Case study comparison. Scopes of application. Functional analysis. Design of composite parts. The market
for composites. Sandwich materials. The sandwich effect. Components. Mechanical analysis. Applications.

Bibliography :
Daniel Gay - Matériaux Composites 3ème édition. Hermès Editeur.
Jean-Marie Berthelot - Matériaux Composites :
comportement mécanique et analyse des structures. Editions Masson, Paris 1996.

Requirements :

Organisation :
2 hours per week.

Evaluation :
Two-hour written examination at the end of the semester.
Mark for reports on practical work (laboratory).

Target :

Manufacturing & Design Project	GMA08-PRCONS
Number of hours : 56.00 h	4.00 ECTS credit
CM : 12.00 h, TP : 44.00 h	hand-out in English and course taught in English
Reference Teacher(s) : LEOTOING Lionel	

Objectives :
This project deals with the study of a mechanical system and the implementation of research techniques for solutions,
geometrical modelling, digital simulation and component dimensioning.

Content :
1) Obtaining solutions from functional specifications.
2) Technical definition of solution (choosing bonds and components).
3) Dimensioning of the components.
4) Geometric optimisation of the system.
5) Integration of manufacturing and assembly constraints.

Bibliography :

Requirements :
GMA07-CMAO2 GMA05-TCONS.

Organisation :
3 hours per week.

Evaluation :
Mark for project.

Target :

Production and Quality Control Management	GMA08-PROD
Number of hours : 28.00 h	3.00 ECTS credit
CM : 14.00 h, TD : 14.00 h	
Reference Teacher(s) : SORRE Frederic	

Objectives :
To manufacture, in accordance with requirements, low-cost, high-quality products, which respect consumers' requirements and
can be supplied in reasonable time. Organisational techniques, production management, quality control, communication.

Content :
I- Experimental methodology: Introduction. Vocabulary and study approach. Calculation tools. Screening. Common
experiment matrices. Analysis of results. Validation of the model. Taguchi's method.
II- Production control. Concept of capability. Quality checking cards: particular cases. Forecasting techniques. Advanced
planning techniques. Organisation in specialised workshops. Manufacturing lines. ERP

Bibliography :
P. Souvay La statistique : outil de la qualité Recueil des normes ISO 9000 G. et M.C. Sado, De l'expérimentation à l'assurance qualité - Afnor Technique Jacques Goupy, Introduction aux plans d'expériences - Dunod

Requirements :
TCM06-ISIP

Organisation :
1 hour per week.

Evaluation :
Two-hour written examination at the end of the semester.

Target :

Robot Modelling	GMA08-MOROB
Number of hours : 42.00 h	3.00 ECTS credit
CM : 16.00 h, TD : 10.00 h, TP : 16.00 h	handout in English
Reference Teacher(s) : MAURINE Patrick	

Objectives :
Methods and basic tools necessary for the modelling of simple, open-chain manipulating robots.

Content :
-Modelling of simple open-chain manipulating robots. Terminology and main definitions.
-Transformation matrixes between vectors, frames and torque.
-Direct and inverse geometrical models.
-Study of singularities.
-Analysis of the workspace.
-Analysis of manipulability. Transfer of velocities and stresses.
-Static equilibrium.

Bibliography :
KHALIL W., DOMBRE E., 1999, « Modélisation, identification et commande des robots », Hermès.

Requirements :
Matrix calculus

Organisation :
2 hours per week

Evaluation :
A two-hour written examination at the end of the semester.
Mark for reports on practical work in the laboratory.

Target :

4GMA Work Placement	GMA08-STAGE
Number of hours : 240.00 h	8.00 ECTS credit
TP : 1.00 h	hand-out in English and course taught in English
Reference Teacher(s) : GAVRUS Adinel	

Objectives :
Students put into practice the industrial context of the scientific and technical skills they have acquired.

Content :
First-hand work experience is an essential step in the education of GMA engineers. The work experience internship at the end
of the eighth semester can last from 8 to 16 weeks and is compulsory. The objective is to solve a real technical issue in an
industrial context. The student has four months, from the end of May to the end of September, to carry out the training course,
by the end of which he will have gained a better insight into the professional world which lies ahead of him.
Each student has the responsibility of finding a host company and the further task of defining a plan for the internship with his
employer. Students are advised that their internship plan must be relevant to the domains of Mechanical Engineering or
Automatics and cannot commence without an Internship Agreement being signed between the company and INSA-Rennes. In
any case, before the establishment of this agreement, a clear plan for the internship must be defined and submitted to the
department for agreement.

Bibliography :

Requirements :

Organisation :
Each student undertakes to find his own work placement. See "Programme" (above) for further details.

Evaluation :
A twenty-page synthesis-report is compulsory and may be written in French or in English (for students having completed their internship abroad). It can be accompanied by one or more appendices of unrestricted length. Each student must present to a jury comprising his tutor(s) and representatives of the host company a poster (designed by himself) describing the context and the objectives of the internship. Note: Reports must not be a chronological description.

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 :

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

Objectives :
Targeted skills :
- working and communicating in a team
- cultural openness
- listening to others
- managing stress

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

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

Bibliography :
Musical scores are distributed at the beginning of the year

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

Organisation :
2 hours group practice per week

Evaluation :
validation without grade

Target :
INSA students, INP, Centrale/Supélec and external students

Semestre 9

Parcours Contrat Pro

1	**GMA09-1**		**Mechanical Engineering and Materials S9**	**7.50**
	GMA09-MECAFORM	O	Metallic Materials: Shaping	4.50
	GMA09-CMP	O	Non-Metallic Materials: Processing	1.00
	GMA09-MNEF	O	Numerical Methods: Nonlinear Finite Elements	2.00
2	**GMA09-2**		**Automation and model-building S9**	**6.00**
	GMA09-ROBOT	O	Robotics II	2.00
	GMA09-SYSME	O	Mechanical Systems	2.00
	GMA09-COMOP	O	Automation III: Optimal Control	2.00
3	**GMA09-3**		**OUVERTURE**	**11.00**
	GMA09-CORO	C	Robust Design	2.00
	GMA09-CODYM	C	Comportement dynamique des matériaux et des structures	2.00
	GMA09-INGAS	C		2.00
	GMA09-VATR	C	Accuracy of Robots and Machine-tools	2.00
	GMA09-PI	O	Industrial project	7.00
	GMA09-ANNUM	C	Analyse numérique pour ingénieur	2.00
4	**HUM09-GMA-CP**		**ENSEIGNEMENTS D'HUMANITE S9**	**3.50**
	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

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

Metallic Materials: Shaping	GMA09-MECAFORM
Number of hours : 60.00 h	4.50 ECTS credit
CM : 34.00 h, PR : 2.00 h, TD : 16.00 h, TP : 8.00 h	
Reference Teacher(s) : GAVRUS Adinel	

Objectives :
Metallurgy of Metallic Materials.Introduction to the plasticity of materials and elasto-(visco)plastic behaviour definition. Study
of the relationship between structure and rheology. Formulation of the rheological and tribological laws. Examination of
mechanical and tribological tests. Description of the principal processes for metals forming. Optimization and Inverse Analysis
Principle.

Content :
1° Mechanical Metallurgy of Metallic Materials.
2° Elasticity, viscoplasticity, plasticity, criteria of plasticity.
3° Elements of physical and mechanical metallurgy concerning metals forming.
4° Rheology and Tribology of metals forming.
5° Analysis of Industrial Metals Forming Processes.
6° Numerical Simulations, Optimization and Inverse Analysis applied to the rheological and tribological properties identification according to the forming conditions.

Bibliography :
[1] J. PHILIBERT A. VIGNES Y. BRECHET P. COMBRADE « Métallurgie du minerai au matériau » Ed Masson 1998
[2] D. FRANCOIS, A. PINEAU, A. ZAOUI, « Comportement mécanique des matériaux », Tome1, Hermes, 1995
PHILIBERT, VIGNES, BRECHET, COMBRE, " Métallurgie du minerai au matériau ", Masson,
[3] J-M. HAUDIN, F. MONTHEILLET ²Notions Fondamentales sur les Matériaux², Ed. S.N.P.M.D., Paris, 1989.
[4] M. BELLET, J-L. CHENOT, L. FOURMENT, E. MASSONI, P. MONTMITONNET ²Séminaire de Plasticité : Eléments Finis et Mise en Forme des Métaux ², Ed. Ecole Nationale Supérieure des Mines de Paris, Sophia Antipolis, 1994.
[5] M. RAPPAZ, M. BELLET, M. DEVILLE ²Modélisation Numérique en Science et Génie des Matériaux², Ed. Presses
Polytechniques et Universitaires Romandes, 1998.

Requirements :
Physics, materials science, technology modules (4th year)
Mechanics of continuous elements (3thd year)
Fluid mechanics (4th year)

Organisation :
Revision of lecture notes. Problems solving: 10 hours

Evaluation :
Two-hour written examination and practical works evaluation.

Target :

Non-Metallic Materials: Processing	GMA09-CMP
Number of hours : 12.00 h	1.00 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : GLORIANT Thierry	

Objectives :
Introduction of Polymers Technology; Physical-Chemical description of Polymers; Structure-Behaviour-Properties Interaction;
Thermo-viscoplasticity and rheological analysis of the melted state; Thermal theory and applications concerning the thermal
analysis; Injection, Extrusion and Calendering Processes Analysis; Rheology of solid polymers; Technology and properties of
ceramics.

Content :
1. Comparison between metals, polymers, ceramics and composites materials and its optimal choice.
2. Introduction to the technology principles of polymers manufacturing.
3. Physical and Chemical description of a polymer.
4. Definition and properties of thermoplastics, thermosettings and elastomers materials.
5. Thermo-viscoplasticity and rheology of polymers in melted state.
6. Thermal Theory and Applications.
7. Manufacturing process for polymers industry.
8. Rheology of solid polymers.
9. Elaboration, properties and technology of ceramics.

Bibliography :
[1] J. F. AGASSANT, P. AVENAS, J.-Ph. SERGENT- "La Mise en Forme des Matériaux Plastiques", Ed. Technique &
Documentation, Ed. Lavoisier, 1996.
[2] J. BOST -"MATIERES PLASTIQUES II : Technologie Plasturgie", Ed. Technique & Documentation, Lavoisier, 1982.
[3] M. REYNE-"LES MATERIAUX NOUVEAUX", Ed. Hermes, Paris, 1990.
[4] M. REYNE "TECHNOLOGIE DES PLASTIQUES", Ed. Hermes, Paris, 1998.
[5] C. GSELL, J.-M. HAUDIN-"INTRODUCTION A LA MECANIQUE DES POLYMERES", Ed. Institut National Polytechnique de Lorraine, 1995.
[6] W.D. KINGERY, H.K. BOWEN, DR UHLMANN -"Introduction to Ceramics", John Wiley & Sons, New-York (1976), ISBN 0.471.47860.1
[7] J.L. CHERMAN -"Caractérisation des poudres et des céramiques", Hermès, Paris (1992), ISBN 2.86601.307.7
[8] L.L. HENCH, R.W. GOULD -"Characterization of Ceramics", M. Dekker Inc, New-York (1971), ISBN 0.8247.1302.8

Requirements :
Physics and Chemistry (1st en 2sd years).
Materials Science (3thd and 4th years).
Continuum Media Mechanics and Fluid Mechanics (3thd and 4th years).

Organisation :
One hour per week.

Evaluation :
Two-hour written examination and project evaluation.

Target :

Numerical Methods: Nonlinear Finite Elements	GMA09-MNEF
Number of hours : 26.00 h	2.00 ECTS credit
CM : 26.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
An extension of the MEFI module (4th year), the consequences of taking material and geometrical nonlinearities into account
in a finite element model are examined. A mini-project on modelling in the nonlinear domain completes the module.

Content :
1. Introduction: Classification of nonlinearities.
2. Matrix formulation of non linearity: understanding tangent and cutting matrix of rigidity.
3. Solution models (Newton-Rahpson).
4. Application to geometrical nonlinearities: Hyperelasticity. Hypoelasticity. Elastoplasticity.
5. Application to geometrical nonlinearity: Lagrangian description "UL" and "TL". Euler's description "ALE". Approximations
for large displacements. Flame and sail effects on thin elements.
6. Application with the Cast 3M program (mini project).

Bibliography :
Zienkiewicz : La méthode des Eléments finis. Edisciences
Gallagher : Introduction au calcul par Eléments Finis. Editions Pluralis Batoz,
Dhatt : Modélisation des structures par éléments
finis. Editions Hermès
K. J. Bathe : Finite Element Procedures in Engineering Analysis. Prentice et Hall

Requirements :
Basics of the mechanics of continuous media and linear finite element modelling.

Organisation :
Two hours per week.

Evaluation :
Two-hour written examination.
Mark for mini-project.

Target :

Robotics II	GMA09-ROBOT
Number of hours : 24.00 h	2.00 ECTS credit
CM : 16.00 h, TD : 8.00 h	
Reference Teacher(s) : ARAKELYAN Vigen	

Objectives :
Theoretical principles to understand the mechanics of articulated robots. Recent developments in direct polynomial kinematics
and the study of the assembly of parallel robots. Inverse kinematics, Statics, Architecture and Dynamics for parallel robots.
Case studies. Tutorials: Simulation of these applications through models using the ADAMS programme.

Content :
Statics of anthropomorphic and parallel manipulators. Direct and inverse kinematics of parallel manipulators. Generalisation of
movements in articulated and operational space: Polynomial interpolation and calculating minimal time. Newton-Euler and
Newton-Lagrange equations: Application to robotic systems. Balancing of manipulating arms and parallel robots: application
to walking and manual-manipulator robotic systems. Open-loop kinematics for dynamic decoupling and linearization of
movement equations for manipulators. Architecture: calculations and optimisation.

Bibliography :
1. O. Bottema, B. Roth. Theoretical Mechanics. Dover Publications, New York, 1990, 558p.
2. J. Angeles. Fundamentals of robotic mechanical systems. Springer, 2003, 521p.
3. L.W. Tsai. Robot Analysis. John Wiley et Sons, 1999, 505p. Evaluation

Requirements :

Organisation :

Evaluation :
Two-hour written examination at the end of the semester.

Target :

Mechanical Systems	GMA09-SYSME
Number of hours : 24.00 h	2.00 ECTS credit
CM : 16.00 h, TD : 8.00 h	hand-out in English and course taught in English
Reference Teacher(s) : ARAKELYAN Vigen	

Objectives :
- New analytical methods for the design and fabrication of modern machines.
- Concepts and techniques of the mechanics of complex systems.
- General principles and methods for the study of rigid/articulated multi-body systems.
- Case Studies.

Content :
Use of graphs to describe systems. Position: kinematic (the Gosselin-Angeles method) and dynamic. Kinematic analysis of
closed-loop spatial mechanisms using the Denavit-Hartenberg method. Synthesis of multiple body articulated systems:
Burmester's problem and the problem of the approximate reproduction of a given motion (Roth-Gupta method). Dynamic
synthesis of multiple body systems. Moving moment and optimisation methods. Optimal balance for complex systems based
on the Techichev's approximation. Dynamics of multiple body closed loop systems with multiple degrees of liberty. The
mechanical-electronic approach to the study of mechanical systems.

Bibliography :
1. L.W. Tsai. Mechanism Design. CRC Press, 2001, 311p.
2. H. Dresig., F. Holzweißer. Maschinendynamik. Springer, 2004, 526p.
3. O. Bottema, B. Roth. Theoretical Mechanics. Dover Publications, New York, 1990, 558p.

Requirements :

Organisation :

Evaluation :
Two-hour written examination at the end of the semester.

Target :

Automation III: Optimal Control	GMA09-COMOP
Number of hours : 24.00 h	2.00 ECTS credit
CM : 10.00 h, TD : 6.00 h, TP : 8.00 h	
Reference Teacher(s) : GUEGAN Sylvain	

Objectives :
Problems associated with optimal control of dynamic systems, including a number of practical problems: Control with minimal
expenditure of energy, Control in minimal time, etc. Study of linear quadratic commands. Introduction of robustness of the
Gaussian linear quadratic commands; H2 and H¥

Content :
Mathematics in optimal control. Calculation of variations. Principle of the maximum. Dynamic programming. Optimal control
of linear systems. Additions from Lyanpunov's theory. Quadratic optimisation of continuous systems. Continuous stationary
regulator. Quadratic optimisation of discrete systems. Discrete stationary regulator. Linear quadratic command system + stability. Gaussian linear quadratic commands H2 et H¥

Bibliography :
KWAKERNAAK H. SIVAN R., 1972, « Linear optimal control systems», John Wiley 1 Sons, Inc.
THOMAS Y., 1992 « Signaux et systèmes linéaires » 1991, Masson
DE LARMINAT Ph. 1993, « Automatique, commande des systèmes linéaires », Hermès.

Requirements :
Signaux et Systèmes - Automatique 1 - Automatique 2

Organisation :
Revision of lecture notes. Preparation of exercises, problems and practical work (Two hours per week).

Evaluation :
Three-hour written examination at the end of the semester(lecture notes and handouts allowed).
Two practical work reports .

Target :

Robust Design	GMA09-CORO
Number of hours : 24.00 h	2.00 ECTS credit
CM : 10.00 h, TP : 14.00 h	
Reference Teacher(s) : LEOTOING Lionel	

Objectives :
The choice of an optimal mechanical solution requires the study of its robustness. The evaluation of the reliability of the
product can be an efficient tool for this choice.

Content :
1 - Main optimization algorithms
2 - Introduction to Mechanical reliability
3 - Applications on optimization software ModeFrontier
4 - Project
5 - Lecture on industrial applications

Bibliography :

Requirements :
GMA07-CMAO2

Organisation :
1 hour per week

Evaluation :
- 1 two-hour written examination
- 1 mark for practical work

Target :

Comportement dynamique des matériaux et des structures	GMA09-CODYM
Number of hours : 24.00 h	2.00 ECTS credit
CM : 12.00 h, TD : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

	GMA09-INGAS
Number of hours : 24.00 h	2.00 ECTS credit
CM : 16.00 h, TP : 8.00 h	
Reference Teacher(s) : KOUADRI-DAVID Afia	

Objectives :
The majority of industries must integrate during their manufacture a stage of assembly and of welding. In this aim, the engineer in mechanics and automatism must have a global vision of the manufacturing processes, machines of assembly or the welding, their operation but also of their limit for better acting and thus guaranteeing the reliability of the end product. Also the objective of this module is to bring to the engineers tools and methods to acquire a competence in the field of the engineering of assembly by the taking into account the process of the welding as well as choice of material in metallurgical, thermal and mechanical terms.

Content :
The module is carried out in the form of course (16 H) and 8 hours of TP. The course part is broken up into several fields which constitute the training of an engineer welder and who requires several level of knowledge:
1. Run
- Process study: Presentation and study of the various processes of welding, control parameters of the process,
- Materials study: Influence of the processes and parameters on the metallurgical and thermal aspects.
- Mechanical study: Impact and effects on the welded structures.
- Coupling: Study of the coupling Process-Material-Mechanics.
- Defects of welding study: Appreciation and recognition of the various types of defects generated by welding.
- Quality controls of the structures: methods of destructive and nondestructive control of the welded structures.
- Qualification: Study of the step of qualification of an engineer welder: QMOS and DMOS.
- Application to various welded systems in automotive, aeronautic¿..

2. Work practice
The TP are realized in the form of welding of plates by the use of various processes. A mechanical qualification is carried out by the students in order to confirm the influence of the process on the final quality of the process. Various tests are carried out to highlight the proceeded coupling material-mechanics.

Bibliography :

Requirements :
- Knowledge of the mechanics of materials
- Knowledge of the manufacturing processes

Organisation :
- 2 H of course per week
- 8 hours of pratics (TP)

Evaluation :
- Exam during 2 Hours
- Practices (TP)

Target :

Accuracy of Robots and Machine-tools	GMA09-VATR
Number of hours : 24.00 h	2.00 ECTS credit
CM : 8.00 h, TD : 8.00 h, TP : 8.00 h	handout in English
Reference Teacher(s) : SOHIER Christophe	

Objectives :
The Mechanics Industry is a complex environment with many branches of activity. To be competitive each branch has to
involve automated machines and robots. As a result, the mechanical engineers must have a global overview of these machines
in order to well understand their behaviour and their limits. For machining and assembly applications, the trajectories of the
machines-tools and robots have to be accurately controlled. Therefore the objective of this module is to provide the students
the knowledge and the tools required to enhance the static and dynamic accuracies of robots and machines.

Content :
Courses:
1/ Problem statement:
Problem of Machine and robot accuracy,
Off-line Programming,
CAD/CAM
2/ Objectives and available calibration methods :
Modelling
Identification
Measurement
Compensation
Tutorials:
1/ Practical verification of machines-tool and robot accuracy
2/ Machine and robot modelling
3/ Application to calibration methods to machines and robots
Laboratory :
1/ Application to 3 and 5 axis machine tools
2/ Application to industrial anthropomorphic robots (KUKA, FANUC)

Bibliography :

Requirements :

Organisation :
12 hours

Evaluation :

Target :

Industrial project	GMA09-PI
Number of hours : 110.00 h	7.00 ECTS credit
TD : 110.00 h	hand-out in English and course taught in English
Reference Teacher(s) : COURTEILLE Eric	

Objectives :
Solving problems in a simulated industrial situation. A look at companies working in the field of Mechanical and Control
Systems Engineering.

Content :
Working alone or in pairs, students must complete a project proposed by a company which is involved in mechanical
engineering, mechanics or automation.

Bibliography :

Requirements :

Organisation :
From 6 to 10 hours per week.

Evaluation :
Two oral presentations:(a) On the planning and organisation of the project (15%) (b) At the end of the project(30%).
Written report (30%).
Mark awarded by teachers and company supervisors (25%).

Target :

Analyse numérique pour ingénieur	GMA09-ANNUM
Number of hours : 24.00 h	2.00 ECTS credit
CM : 12.00 h, TD : 8.00 h, TP : 4.00 h	
Reference Teacher(s) : GAVRUS Adinel	

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 :

Semestre 9

Parcours Formation Initiale GMA

1	**GMA09-1**		**Mechanical Engineering and Materials S9**	**7.50**
	GMA09-MECAFORM	O	Metallic Materials: Shaping	4.50
	GMA09-CMP	O	Non-Metallic Materials: Processing	1.00
	GMA09-MNEF	O	Numerical Methods: Nonlinear Finite Elements	2.00
2	**GMA09-2**		**Automation and model-building S9**	**6.00**
	GMA09-ROBOT	O	Robotics II	2.00
	GMA09-SYSME	O	Mechanical Systems	2.00
	GMA09-COMOP	O	Automation III: Optimal Control	2.00
3	**GMA09-3**		**OUVERTURE**	**11.00**
	GMA09-CORO	C	Robust Design	2.00
	GMA09-CODYM	C	Comportement dynamique des matériaux et des structures	2.00
	GMA09-INGAS	C		2.00
	GMA09-VATR	C	Accuracy of Robots and Machine-tools	2.00
	GMA09-PI	O	Industrial project	7.00
	GMA09-ANNUM	C	Analyse numérique pour ingénieur	2.00
4	**HUM09**		**Non-scientific syllabus S9**	**5.50**
	HUM09-ANGL-CONV	C	English S9 Conversation	1.50
	HUM09-ANGL-TOEIC	C	TOEIC 5th year	1.50
	HUM09-PM-A	C	Economics, Law and Business Studies A - LEAN 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
	EII09-EVST	C	Internship evaluation	1.00
	HUM09-PM-G	C	Economics, Law and Business Studies G (serious game)	2.00
	EII09-HUMT	C	Societal responsibility of business	1.00
	EII09-EVST	C	Internship evaluation	1.00
	INF09-STGDATING	C	Internship Dating	1.00
	GCU09-SPEC-GPC	C	Management of construction project	1.00
	GCU09-SPEC-GPD	C	BIM Project Management	1.00
	INF09-ETHIQUE	C	Formation éthique de l'ingénieur	1.00
	HUM09-PM-PRO	C	Economics, Law and Business Studies (Professional management)	2.00
	DET10-SPEC PRO	C	Expérience en entreprise	2.00
6	**HUMF1-ELSA Mus**		**Music with studies**	**1.00**
	HUMF1-MUS	F	Music Studies	1.00

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

Metallic Materials: Shaping	GMA09-MECAFORM
Number of hours : 60.00 h	4.50 ECTS credit
CM : 34.00 h, PR : 2.00 h, TD : 16.00 h, TP : 8.00 h	
Reference Teacher(s) : GAVRUS Adinel	

Objectives :
Metallurgy of Metallic Materials.Introduction to the plasticity of materials and elasto-(visco)plastic behaviour definition. Study
of the relationship between structure and rheology. Formulation of the rheological and tribological laws. Examination of
mechanical and tribological tests. Description of the principal processes for metals forming. Optimization and Inverse Analysis
Principle.

Content :
1° Mechanical Metallurgy of Metallic Materials.
2° Elasticity, viscoplasticity, plasticity, criteria of plasticity.
3° Elements of physical and mechanical metallurgy concerning metals forming.
4° Rheology and Tribology of metals forming.
5° Analysis of Industrial Metals Forming Processes.
6° Numerical Simulations, Optimization and Inverse Analysis applied to the rheological and tribological properties identification according to the forming conditions.

Bibliography :
[1] J. PHILIBERT A. VIGNES Y. BRECHET P. COMBRADE « Métallurgie du minerai au matériau » Ed Masson 1998
[2] D. FRANCOIS, A. PINEAU, A. ZAOUI, « Comportement mécanique des matériaux », Tome1, Hermes, 1995
PHILIBERT, VIGNES, BRECHET, COMBRE, " Métallurgie du minerai au matériau ", Masson,
[3] J-M. HAUDIN, F. MONTHEILLET ²Notions Fondamentales sur les Matériaux², Ed. S.N.P.M.D., Paris, 1989.
[4] M. BELLET, J-L. CHENOT, L. FOURMENT, E. MASSONI, P. MONTMITONNET ²Séminaire de Plasticité : Eléments Finis et Mise en Forme des Métaux ², Ed. Ecole Nationale Supérieure des Mines de Paris, Sophia Antipolis, 1994.
[5] M. RAPPAZ, M. BELLET, M. DEVILLE ²Modélisation Numérique en Science et Génie des Matériaux², Ed. Presses
Polytechniques et Universitaires Romandes, 1998.

Requirements :
Physics, materials science, technology modules (4th year)
Mechanics of continuous elements (3thd year)
Fluid mechanics (4th year)

Organisation :
Revision of lecture notes. Problems solving: 10 hours

Evaluation :
Two-hour written examination and practical works evaluation.

Target :

Non-Metallic Materials: Processing	GMA09-CMP
Number of hours : 12.00 h	1.00 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : GLORIANT Thierry	

Objectives :
Introduction of Polymers Technology; Physical-Chemical description of Polymers; Structure-Behaviour-Properties Interaction;
Thermo-viscoplasticity and rheological analysis of the melted state; Thermal theory and applications concerning the thermal
analysis; Injection, Extrusion and Calendering Processes Analysis; Rheology of solid polymers; Technology and properties of
ceramics.

Content :
1. Comparison between metals, polymers, ceramics and composites materials and its optimal choice.
2. Introduction to the technology principles of polymers manufacturing.
3. Physical and Chemical description of a polymer.
4. Definition and properties of thermoplastics, thermosettings and elastomers materials.
5. Thermo-viscoplasticity and rheology of polymers in melted state.
6. Thermal Theory and Applications.
7. Manufacturing process for polymers industry.
8. Rheology of solid polymers.
9. Elaboration, properties and technology of ceramics.

Bibliography :
[1] J. F. AGASSANT, P. AVENAS, J.-Ph. SERGENT- "La Mise en Forme des Matériaux Plastiques", Ed. Technique &
Documentation, Ed. Lavoisier, 1996.
[2] J. BOST -"MATIERES PLASTIQUES II : Technologie Plasturgie", Ed. Technique & Documentation, Lavoisier, 1982.
[3] M. REYNE-"LES MATERIAUX NOUVEAUX", Ed. Hermes, Paris, 1990.
[4] M. REYNE "TECHNOLOGIE DES PLASTIQUES", Ed. Hermes, Paris, 1998.
[5] C. GSELL, J.-M. HAUDIN-"INTRODUCTION A LA MECANIQUE DES POLYMERES", Ed. Institut National Polytechnique de Lorraine, 1995.
[6] W.D. KINGERY, H.K. BOWEN, DR UHLMANN -"Introduction to Ceramics", John Wiley & Sons, New-York (1976), ISBN 0.471.47860.1
[7] J.L. CHERMAN -"Caractérisation des poudres et des céramiques", Hermès, Paris (1992), ISBN 2.86601.307.7
[8] L.L. HENCH, R.W. GOULD -"Characterization of Ceramics", M. Dekker Inc, New-York (1971), ISBN 0.8247.1302.8

Requirements :
Physics and Chemistry (1st en 2sd years).
Materials Science (3thd and 4th years).
Continuum Media Mechanics and Fluid Mechanics (3thd and 4th years).

Organisation :
One hour per week.

Evaluation :
Two-hour written examination and project evaluation.

Target :

Numerical Methods: Nonlinear Finite Elements	GMA09-MNEF
Number of hours : 26.00 h	2.00 ECTS credit
CM : 26.00 h	
Reference Teacher(s) : RAGNEAU Eric	

Objectives :
An extension of the MEFI module (4th year), the consequences of taking material and geometrical nonlinearities into account
in a finite element model are examined. A mini-project on modelling in the nonlinear domain completes the module.

Content :
1. Introduction: Classification of nonlinearities.
2. Matrix formulation of non linearity: understanding tangent and cutting matrix of rigidity.
3. Solution models (Newton-Rahpson).
4. Application to geometrical nonlinearities: Hyperelasticity. Hypoelasticity. Elastoplasticity.
5. Application to geometrical nonlinearity: Lagrangian description "UL" and "TL". Euler's description "ALE". Approximations
for large displacements. Flame and sail effects on thin elements.
6. Application with the Cast 3M program (mini project).

Bibliography :
Zienkiewicz : La méthode des Eléments finis. Edisciences
Gallagher : Introduction au calcul par Eléments Finis. Editions Pluralis Batoz,
Dhatt : Modélisation des structures par éléments
finis. Editions Hermès
K. J. Bathe : Finite Element Procedures in Engineering Analysis. Prentice et Hall

Requirements :
Basics of the mechanics of continuous media and linear finite element modelling.

Organisation :
Two hours per week.

Evaluation :
Two-hour written examination.
Mark for mini-project.

Target :

Robotics II	GMA09-ROBOT
Number of hours : 24.00 h	2.00 ECTS credit
CM : 16.00 h, TD : 8.00 h	
Reference Teacher(s) : ARAKELYAN Vigen	

Objectives :
Theoretical principles to understand the mechanics of articulated robots. Recent developments in direct polynomial kinematics
and the study of the assembly of parallel robots. Inverse kinematics, Statics, Architecture and Dynamics for parallel robots.
Case studies. Tutorials: Simulation of these applications through models using the ADAMS programme.

Content :
Statics of anthropomorphic and parallel manipulators. Direct and inverse kinematics of parallel manipulators. Generalisation of
movements in articulated and operational space: Polynomial interpolation and calculating minimal time. Newton-Euler and
Newton-Lagrange equations: Application to robotic systems. Balancing of manipulating arms and parallel robots: application
to walking and manual-manipulator robotic systems. Open-loop kinematics for dynamic decoupling and linearization of
movement equations for manipulators. Architecture: calculations and optimisation.

Bibliography :
1. O. Bottema, B. Roth. Theoretical Mechanics. Dover Publications, New York, 1990, 558p.
2. J. Angeles. Fundamentals of robotic mechanical systems. Springer, 2003, 521p.
3. L.W. Tsai. Robot Analysis. John Wiley et Sons, 1999, 505p. Evaluation

Requirements :

Organisation :

Evaluation :
Two-hour written examination at the end of the semester.

Target :

Mechanical Systems	GMA09-SYSME
Number of hours : 24.00 h	2.00 ECTS credit
CM : 16.00 h, TD : 8.00 h	hand-out in English and course taught in English
Reference Teacher(s) : ARAKELYAN Vigen	

Objectives :
- New analytical methods for the design and fabrication of modern machines.
- Concepts and techniques of the mechanics of complex systems.
- General principles and methods for the study of rigid/articulated multi-body systems.
- Case Studies.

Content :
Use of graphs to describe systems. Position: kinematic (the Gosselin-Angeles method) and dynamic. Kinematic analysis of
closed-loop spatial mechanisms using the Denavit-Hartenberg method. Synthesis of multiple body articulated systems:
Burmester's problem and the problem of the approximate reproduction of a given motion (Roth-Gupta method). Dynamic
synthesis of multiple body systems. Moving moment and optimisation methods. Optimal balance for complex systems based
on the Techichev's approximation. Dynamics of multiple body closed loop systems with multiple degrees of liberty. The
mechanical-electronic approach to the study of mechanical systems.

Bibliography :
1. L.W. Tsai. Mechanism Design. CRC Press, 2001, 311p.
2. H. Dresig., F. Holzweißer. Maschinendynamik. Springer, 2004, 526p.
3. O. Bottema, B. Roth. Theoretical Mechanics. Dover Publications, New York, 1990, 558p.

Requirements :

Organisation :

Evaluation :
Two-hour written examination at the end of the semester.

Target :

Automation III: Optimal Control	GMA09-COMOP
Number of hours : 24.00 h	2.00 ECTS credit
CM : 10.00 h, TD : 6.00 h, TP : 8.00 h	
Reference Teacher(s) : GUEGAN Sylvain	

Objectives :
Problems associated with optimal control of dynamic systems, including a number of practical problems: Control with minimal
expenditure of energy, Control in minimal time, etc. Study of linear quadratic commands. Introduction of robustness of the
Gaussian linear quadratic commands; H2 and H¥

Content :
Mathematics in optimal control. Calculation of variations. Principle of the maximum. Dynamic programming. Optimal control
of linear systems. Additions from Lyanpunov's theory. Quadratic optimisation of continuous systems. Continuous stationary
regulator. Quadratic optimisation of discrete systems. Discrete stationary regulator. Linear quadratic command system + stability. Gaussian linear quadratic commands H2 et H¥

Bibliography :
KWAKERNAAK H. SIVAN R., 1972, « Linear optimal control systems», John Wiley 1 Sons, Inc.
THOMAS Y., 1992 « Signaux et systèmes linéaires » 1991, Masson
DE LARMINAT Ph. 1993, « Automatique, commande des systèmes linéaires », Hermès.

Requirements :
Signaux et Systèmes - Automatique 1 - Automatique 2

Organisation :
Revision of lecture notes. Preparation of exercises, problems and practical work (Two hours per week).

Evaluation :
Three-hour written examination at the end of the semester(lecture notes and handouts allowed).
Two practical work reports .

Target :

Robust Design	GMA09-CORO
Number of hours : 24.00 h	2.00 ECTS credit
CM : 10.00 h, TP : 14.00 h	
Reference Teacher(s) : LEOTOING Lionel	

Objectives :
The choice of an optimal mechanical solution requires the study of its robustness. The evaluation of the reliability of the
product can be an efficient tool for this choice.

Content :
1 - Main optimization algorithms
2 - Introduction to Mechanical reliability
3 - Applications on optimization software ModeFrontier
4 - Project
5 - Lecture on industrial applications

Bibliography :

Requirements :
GMA07-CMAO2

Organisation :
1 hour per week

Evaluation :
- 1 two-hour written examination
- 1 mark for practical work

Target :

Comportement dynamique des matériaux et des structures	GMA09-CODYM
Number of hours : 24.00 h	2.00 ECTS credit
CM : 12.00 h, TD : 12.00 h	
Reference Teacher(s) :	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

	GMA09-INGAS
Number of hours : 24.00 h	2.00 ECTS credit
CM : 16.00 h, TP : 8.00 h	
Reference Teacher(s) : KOUADRI-DAVID Afia	

Objectives :
The majority of industries must integrate during their manufacture a stage of assembly and of welding. In this aim, the engineer in mechanics and automatism must have a global vision of the manufacturing processes, machines of assembly or the welding, their operation but also of their limit for better acting and thus guaranteeing the reliability of the end product. Also the objective of this module is to bring to the engineers tools and methods to acquire a competence in the field of the engineering of assembly by the taking into account the process of the welding as well as choice of material in metallurgical, thermal and mechanical terms.

Content :
The module is carried out in the form of course (16 H) and 8 hours of TP. The course part is broken up into several fields which constitute the training of an engineer welder and who requires several level of knowledge:
1. Run
- Process study: Presentation and study of the various processes of welding, control parameters of the process,
- Materials study: Influence of the processes and parameters on the metallurgical and thermal aspects.
- Mechanical study: Impact and effects on the welded structures.
- Coupling: Study of the coupling Process-Material-Mechanics.
- Defects of welding study: Appreciation and recognition of the various types of defects generated by welding.
- Quality controls of the structures: methods of destructive and nondestructive control of the welded structures.
- Qualification: Study of the step of qualification of an engineer welder: QMOS and DMOS.
- Application to various welded systems in automotive, aeronautic¿..

2. Work practice
The TP are realized in the form of welding of plates by the use of various processes. A mechanical qualification is carried out by the students in order to confirm the influence of the process on the final quality of the process. Various tests are carried out to highlight the proceeded coupling material-mechanics.

Bibliography :

Requirements :
- Knowledge of the mechanics of materials
- Knowledge of the manufacturing processes

Organisation :
- 2 H of course per week
- 8 hours of pratics (TP)

Evaluation :
- Exam during 2 Hours
- Practices (TP)

Target :

Accuracy of Robots and Machine-tools	GMA09-VATR
Number of hours : 24.00 h	2.00 ECTS credit
CM : 8.00 h, TD : 8.00 h, TP : 8.00 h	handout in English
Reference Teacher(s) : SOHIER Christophe	

Objectives :
The Mechanics Industry is a complex environment with many branches of activity. To be competitive each branch has to
involve automated machines and robots. As a result, the mechanical engineers must have a global overview of these machines
in order to well understand their behaviour and their limits. For machining and assembly applications, the trajectories of the
machines-tools and robots have to be accurately controlled. Therefore the objective of this module is to provide the students
the knowledge and the tools required to enhance the static and dynamic accuracies of robots and machines.

Content :
Courses:
1/ Problem statement:
Problem of Machine and robot accuracy,
Off-line Programming,
CAD/CAM
2/ Objectives and available calibration methods :
Modelling
Identification
Measurement
Compensation
Tutorials:
1/ Practical verification of machines-tool and robot accuracy
2/ Machine and robot modelling
3/ Application to calibration methods to machines and robots
Laboratory :
1/ Application to 3 and 5 axis machine tools
2/ Application to industrial anthropomorphic robots (KUKA, FANUC)

Bibliography :

Requirements :

Organisation :
12 hours

Evaluation :

Target :

Industrial project	GMA09-PI
Number of hours : 110.00 h	7.00 ECTS credit
TD : 110.00 h	hand-out in English and course taught in English
Reference Teacher(s) : COURTEILLE Eric	

Objectives :
Solving problems in a simulated industrial situation. A look at companies working in the field of Mechanical and Control
Systems Engineering.

Content :
Working alone or in pairs, students must complete a project proposed by a company which is involved in mechanical
engineering, mechanics or automation.

Bibliography :

Requirements :

Organisation :
From 6 to 10 hours per week.

Evaluation :
Two oral presentations:(a) On the planning and organisation of the project (15%) (b) At the end of the project(30%).
Written report (30%).
Mark awarded by teachers and company supervisors (25%).

Target :

Analyse numérique pour ingénieur	GMA09-ANNUM
Number of hours : 24.00 h	2.00 ECTS credit
CM : 12.00 h, TD : 8.00 h, TP : 4.00 h	
Reference Teacher(s) : GAVRUS Adinel	

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 :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

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

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

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

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

Bibliography :
Given during the course

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

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

Evaluation :
Continuous assessment (collective work)

Target :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

Internship Dating	INF09-STGDATING
Number of hours : 24.00 h	1.00 ECTS credit
CONF : 24.00 h	
Reference Teacher(s) : BLOUIN Arnaud	

Objectives :
The purpose of this module is to complete the curriculum by knowledge, practices, industrial problems not seen in other modules. It gives students a better knowledge of business world, its internal and external ecosystem, professions. It is also a way to build links between students and companies.

Content :
The "stage dating" allows students to have several short interviews of 10mn with different companies.

Conferences are done by industrial contributors, on different subjects like:
- data management, data science, big data
- introduction to the profession of IT architect

Conferences can be 2 hours long, several modules of 2 hours or organized on a whole day.

Bibliography :

Requirements :

Organisation :
A group of student volunteers, with the teacher in charge of the module, define and organize the different conferences.

Evaluation :
Validation on the presence of the student

Target :

Management of construction project	GCU09-SPEC-GPC
Number of hours : 18.00 h	1.00 ECTS credit
CM : 18.00 h	
Reference Teacher(s) : KAMALI BERNARD Siham	

Objectives :
Presenting the different actors involved in project of construction, the operational organisation of the project, the different requirements to be fulfilled, the different phases to be achieved in a project, and the management techniques and tools to be used for this purpose.

Content :
Part 1
The industrial process and fulfillment of missions
Project actors (Project Owner, Project manager, Execution Company, Controller…): Structures, Responsibilities, Expertise, Means.
The project: Structure, organization, and evolution.
Strategies of project management: organization, supervision, modifications, coordination, subcontracting, delivery
Quality assurance and audits
Management of crises and conflicts

Part 2
Actors of technical management of a project: Project Director, Project Supervisor, Programming Engineer, Project Engineer, Specialty Leader…)
Management of technical documents
Management of works
Management of modifications
Management de delays (study, logistics, execution, delivery…
Operational techniques for cost control
Multi-component programming of projects (time, human resources, logistics, cost, risk…).

Online organization of projects and co-contracting

Bibliography :

Requirements :

Organisation :
Plenary lectures supplemented by case studies to illustrate the presented concept of project management. A challenge is organised for applying skills in real-like situations.

Evaluation :
The evaluation concerns the presented project during the challenge.

Target :
5GCU

BIM Project Management	GCU09-SPEC-GPD
Number of hours : 18.00 h	1.00 ECTS credit
CM : 18.00 h	
Reference Teacher(s) : NGUYEN Quang Huy	

Objectives :
BIM technology is a process that involves the creation and use of an intelligent and configurable 3D model to make better decisions about a project and communicate them. This will involve designing, visualizing, simulating, collaborating and managing more easily throughout the project lifecycle. This course aims to introduce you to BIM technology in building project management.

Content :
Introduction to BIM

The digital technology in the construction industry
The main national and international users
Technical terms of the BIM
The digitization of trades
Technological watch
The implementation of a BIM approach

Interoperability

The challenges of openBIM
The IFC
The BCF
The Facility management

Modeling by BIM approach

Modeling a project by tender mission
Structural modeling
The point clouds
Introduction to Dynamo
Content creation
Architectural modeling

Network modeling

Communicating in a BIM approach
PC and digital DOE
Collaborative platforms
Digital communication tools
Virtual reality and augmented reality
4D simulation

Quality control in BIM approach

Automated and iterative control
Steering and refereeing a synthesis
The point clouds
The digital synthesis model

BIM approach methods

The site installation plan
3D phasing
The layout of facades
The banches cycle
The establishment of security element
The operating mode
BCF in different applications
Interference detection in Revit

Interference detection in Solibri Model Checker
Taking into account the specificities of the trades
Consideration of transitional phases of construction site or maintenance phases

Bibliography :
• De la maquette numérique au BIM, Eyrolles
BIM et architecture, DUNOD
Le BIM appliqué à la gestion du projet de construction: Outils, méthodes et flux de travaux, David McCool et Brad Hardin

Requirements :
Revit

Organisation :
8 hours of lectures and 8 hours of tutorials
Copies of handouts

Evaluation :
Mini-Project

Target :
5GCU

Formation éthique de l'ingénieur	INF09-ETHIQUE
Number of hours : 16.00 h	1.00 ECTS credit
CM : 12.00 h, TD : 4.00 h	
Reference Teacher(s) : CELLIER-BELLINA Peggy	

Objectives :

Content :

Bibliography :

Requirements :

Organisation :

Evaluation :

Target :

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 :

Expérience en entreprise	DET10-SPEC PRO
Number of hours : 30.00 h	2.00 ECTS credit
PR : 0.00 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 10

Parcours Contrat Pro

1	GMA10-1		Final Year Project	30.00
	GMA10-PFE	O	Final Year Project	30.00

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

Final Year Project	GMA10-PFE
Number of hours : 350.00 h	30.00 ECTS credit
ST : 350.00 h	hand-out in English and course taught in English
Reference Teacher(s) : GAVRUS Adinel	

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

Content :
- Industrial or research laboratory's work placement with agreement (junior engineer level).
- At least 16 weeks duration and maximum 6 months.
- In France or abroad.
- Must be carried out in the second semester of the 5th year of studies.

Bibliography :

Requirements :

Organisation :
Writing a final report
Defence of the internship

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

Target :

Semestre 10

Parcours Formation Initiale GMA

1	GMA10-1		Final Year Project	30.00
	GMA10-PFE	O	Final Year Project	30.00

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

Final Year Project	GMA10-PFE
Number of hours : 350.00 h	30.00 ECTS credit
ST : 350.00 h	hand-out in English and course taught in English
Reference Teacher(s) : GAVRUS Adinel	

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

Content :
- Industrial or research laboratory's work placement with agreement (junior engineer level).
- At least 16 weeks duration and maximum 6 months.
- In France or abroad.
- Must be carried out in the second semester of the 5th year of studies.

Bibliography :

Requirements :

Organisation :
Writing a final report
Defence of the internship

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

Target :