Technical Engineering English Programme

ADMISSION REQUIREMENTS

This program is intended for International and French students who have completed six to eight semesters of study (180 to 240 ECTS) at undergraduate level in Mechanical and Industrial Engineering.

Course Title	Course Code	ECTS Credits	First / Second Semester
Mechanical Engineering			
Energetics	8KEL1M04	3	2
Biomechanical Characterization and Modeling of Biological Tissues	9KEL1M16		1
The Multibody System Method Applied to the Human Body	9KEL1M20	3	1
Numerical Methods Applied to Biomedical Applications	9KEL1M15	6	1
Material Behaviors	8KEL1M15	2	2
Thermics	6KEL1M03	2	2
Technology of internal combustion engines	8KEL1M20	3	2
Industrial Engineering			
Sustainable Development	8KEL1M29	1	2
Integrated Logistics Support in Systems Engineering	9KEL1M98	3	1
Project management: tools and technics	6KEL1M14	1	2
Modeling, Analysis and Control of Manufacturing Systems Based on Petri Nets	9KEL1M0F	1	1
Applied Engineering			
Electric Energy Transport	9KEL1M27	1	1
Biomimetics	9KEL1M21	3.5	1
Prosthetic Device Design and Manufacturing	9KEL1M17	5	1
From Mechano-Transduction to Rehabilitation	9KEL1M18	1,5	1
Biomedical Basic Knowledge	9KEL1M22	2.5	1
Simulation with Star-CCM+	9KEL1M25	3,5	1
Transversal Project	9KEL1M19	4	1
French as a Foreign Language		2	1 / 2

Research project in research laboratory	30	2
Or Work placement in industry	30	2

CREDITS

ENIM applies the European Credit Transfer System (ECTS) to express student workload. One ECTS represents approximately 28 hours of work, which include hours of lectures, applied exercises, lab work and private study. You can earn 30 credits per semester; a full academic year is 60 credits.

INTERNATIONAL TEAMWORK

During a semester or one year, you will participate with an international group of students from various universities partners, including engineering students from ENIM, and with diverse education and cultural backgrounds. The language of instruction is English, with French as a foreign language.

STUDY PERIOD AND APPLICATION

Study period is from September to end of June. A maximum of 12 international students is accommodated.

Contact International office: enim-relinter-contact@univ-lorraine.fr ,
Academic coordinators: adrien.baldit@univ-lorraine.fr/ mamadou.coulibaly@univ-lorraine.fr

Course title	Thermics
Course Code	6KEL1M03
Field of study	Heat transfert
Offered	Summer
Coefficient	2
ECTS-credits	2 ECTS
Language	English
Prerequisites	- Fluid mechanics (flow regimes) - Solving differential equations, Laplace transforms method
Teaching method	Lectures : 10h Tutorials : 10h Practical : 16h Personal : 28h

Motivation

This course provides the basic equations and the general methodology to study heat transfer processes in mechanical systems and to design and develop heat exchangers

Learning objectives

- Knowing the basics on thermal problems approach (elementary knowledge, use of Wolfram Mathematica software).
- Minimum knowledge on heat exchanges processes.

Contents

- Conduction en régime permanent et variable
- Convection couche limite thermique : lois adimensionnelles
- Méthodes numériques et équation de Fourier
- Méthodes de calcul d'un échangeur de chaleur

Literature	(Une ou plusieurs références bibliographiques dont les étudiants pourront éventuellement se servir comme support)
Assessment	2 one-hour written exams
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	N. BONFOH (napo.bonfoh@univ-metz.fr)

Course title	Project management : tools and technics
Course Code	6KEL1M14
Field of study	Production Engineering
Offered	summer term
Coefficient	0.5
ECTS-credits	1
Language	English
Prerequisites	none
Teaching method	Lectures : 0 Tutorials : 8 Practical : 0 Personal : 12

Motivation

Project management is a transversal tool essential when a collaborative work is needed to reach an objective. It provides a backbone for the entire progression to the objective and a set of techniques and methods useful to prepare, plan and monitor the process. Then it allows the minimization of delays, costs overrun and uncertainties inherent to all complex actions.

In a larger view, project management gives working and reasoning practices useful in any circumstances

Learning objectives

- Know how to control a project with involved costs. Learn the Budget definition and realisation and how use the actual and budgeted costs comparison to detect variances.
- Focus on investigative and diagnostic procedures to ascertain variance’s causes

Contents

- Budget
- Different notions of cost
- “S” curves tools
- Project Control methods and technics

Literature	none
Assessment	Final written test
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	Daniel ROY

Course title	Energetics
Course Code	8KEL1M04
Field of study	Thermodynamics and fluids mechanics
Offered	Summer
Coefficient	2.5
ECTS-credits	3 ECTS
Language	English
Prerequisites	The basis of thermodynamics : fundamental laws, mass conservation equation, opened and closed systems, equation of state, notion of polytropic change
Teaching method	Lectures : 14h Tutorials : 14h Practical : 12h Personal : 34h
Motivation This course provides the basic equations and the specific methodology to design and develop nozzles, superchargers or turbochargers, used mainly for propulsion in aeronautics, aerospace and automotive.	
Learning objectives - Thinking and reasoning using a scientific methodology on compressible flows ; - Controlling and checking the designing choices made, after analysis and argumentation, of a nozzle or compressor performance	
Contents 2 parts : - Compressible fluids dynamics (7h L, 7h T, 6h P) - Compressors thermodynamics	
Literature	- Anderson, John D. Jr. (2003) [1982]. *Modern Compressible Flow* - John, James E.; Keith, T. G. (2006) [1969]. *Gas Dynamics* (3rd ed.) - Horlock, J. H. (1982). *Axial Flow Compressors: Fluid Mechanics and Thermodynamics* - S.M. Yahya (2011). Turbines, Compressors and Fans (4th Ed.)
Assessment	2 one-hour written exams
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	M. COULIBALY (mamadou.coulibaly@univ-metz.fr)

Course title	Materials behaviors
Course Code	8KEL1M15
Field of study	Mechanical Engineering
Offered	Summer semester
Coefficient	1.5
ECTS-credits	2
Language	English
Prerequisites	Strength of materials Elasticity
Teaching method	Lectures : 12 Tutorials : 12 Personal : 8
Motivation The tools are necessary to design or define structures. The constitutive relations are necessary to be used for example in FE codes to simulate different kind of processes and loadings.	
Learning objectives The students will be available to define and model material behavior of isotropic and heterogeneous materials. Both, elasticity and plasticity will be considered. Concerning heterogeneous behavior, the macroscopic behavior will be defined using the different phases (metallurgy) of the material.	
Contents Tensorial Analysis Elasticity 1D and 3D (continuum mechanics) Plasticity Homogenization methods for heterogeneous materials	
Literature	Constitutive Relations under Impact Loadings Experiments, Theoretical and Numerical Aspects Editors: Lodygowski T., Rusinek A.
Assessment	2 exams
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	Prof. Alexis Rusinek

Course title	Technology of internal combustion engines
Course Code	8KEL1M20
Field of study	Internal combustion engine
Offered	Summer
Coefficient	1.5
ECTS-credits	3
Language	English
Prerequisites	Kinematics and dynamics of solids Thermodynamics Design
Teaching method	Lectures : 6h Tutorials : 6h Practical : 4h Personal : 6h00

Motivation

Knowledge of modern internal combustion engine used in automotive field.

Learning objectives

Understanding of its working principle taken into account the last improvements

Contents

History and evolution of reciprocating piston-crack engines
Thermodynamics : gasoline and diesel engines
Dynamics of the connecting rod-crankschaft-piston system
Improvement of performances' engine : fuel injection, variable compression ratio, turbocharger,

Literature	none
Assessment	1 exam
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	S. Philippon

Course title	Sustainable Development
Course Code	8KEL1M29
Field of study	Industrial engineering
Offered	summer term
Coefficient	1
ECTS-credits	1 ECTS
Language	English
Prerequisites	Project management
Teaching method	Lectures : 4 hours Tutorials : 6 hours Personal : 12 hours
Motivation Being able to develop an individual and / or collective process of change in terms of sustainable development	
Learning objectives To sensitize students to the concept of sustainable development in industrial activities	
Contents Capacity of Earth (context / Issues of sustainable development) Adaptation of the economy and new challenges Ethical and societal concepts, environmental impacts Indicators and standards of sustainable development Carbon Footprint / Greenhouse Gas Protocol / Factor 4 principle biodiversity	
Literature	Meadows, D. H.; Meadows, D. L.; Randers, J., Beyond the limits: global collapse or a sustainable future, *Earthscan Publications Ltd.*London, UK, 1992- ISBN 1-85383-131-X McDonough W. and Braungart M., Cradle to Cradle: Remaking the Way We Make Things, North Point Press, New York, USA, 2002 - ISBN 0-86547-587-3 Anderson, R.C., Business Lessons from a Radical Industrialist, *St Martin's Press*, New York, USA, 2009, ISBN 978-0-312-54349-5
Assessment	1 knowledge test + 1 review of acquired skills
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	Sophie Hennequin

Course title	Modeling, analysis and control of manufacturing systems based on Petri Nets
Course Code	9KEL1M0F
Field of study	Industrial engineering
Offered	Winter or summer term
Coefficient	2
ECTS-credits	1
Language	English
Prerequisites	Linear algebra, basics on computer programming
Teaching method	Lectures : 6 Tutorials : 6 Practical : 0 Personal : 20

Motivation
Develop a systemic vision on the management of industrial systems.

Learning objectives
Enhance the students manufacturing systems modeling skills using top-down and bottom–up systems analysis methods. Enable them to use Petri Net based tools to build models for performance evaluation through analytical methods and simulation. Understand real time challenges in monitoring and control of industrial applications.

Contents
1. Overview of the Petri Net model
2. Modeling of manufacturing systems
3. Performance analysis
4. Control synthesis techniques
5. Introduction to real time systems

Literature	F. Cotet, J. Delacroix, Z. Mammeri, Scheduling in Real-Time Systems, J. Wiley&Sons, 2002. R. David, H. Alla : Discrete, Continuous and Hybrid Petri Nets, Springer-Verlag, 2010. J. M. Proth and X. Xie, Petri nets: a tool for design and management of manufacturing systems, John Wiley & Sons, 1996
Assessment	An examination
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	Alexandre SAVA

Course title	**Numerical Methods for Biomedical Applications**
Course Code	9KEL1M15
Field of study	Mechanics, Biomechanics
Offered	Autumn
ECTS-credits	6 ECTS
Language	English
Prerequisites	Fundamentals of tensor analysis Bases of Continuum Mechanics Constitutive laws in elasticity
Teaching method	Lectures : 20 hours Applied Exercises : 12 hours Lab work : 40 hours Individual : 70 hours

Motivation:

The numerical techniques such as Finite Element Method (FEM) are indispensable to solve complicated tasks of modern design of parts, components, prosthetic solutions or modeling of thermo-mechanical behavior of biological tissues or organs.

Learning objectives

The main goals of this course are as follows:

- to understand the theoretical bases of FEM
- to be able to solve built simple FEM models in elasticity and plasticity,
- to be able to build the geometry of objects from the µCT or DICOM files,
- to execute FE simulations using general purpose software such as Marc or Abaqus or open source codes such as FEBIO- to give the physical bases of X-ray techniques
- to introduce the methods of image segmentation
- to provide practical aspects of use of µCT

Contents	**Level of competency (4)**
• Theoretical bases of FE Methods	2
• FEM in 1D, 2D, 3D elasticity	2
• Segmentation theory	3
• µCT techniques and practical aspects	2
• Biomedical applications in FE	2

Literature	*The Finite element method*, O.C. Zienkiewicz, R.L. Taylor, Butterworth-Heinemann, 2000 *Applied Finite element analysis*, L.J. Segerlind, John Wiley &Sons, 1984
Assessment	Written (2h), 2 projects
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	A.S. BONNET
More contact persons	A.S. BONNET, C. DREISTADT, T. GAJEWSKI, C. LAURENT, P. LIPINSKI, J. TARASIUK

Course title	**Biomechanical Characterization and Modeling of Biological Tissues**
Course Code	9KEL1M16
Field of study	Mechanics, Biomechanics
Offered	Autumn
ECTS-credits	3 ECTS
Language	English
Prerequisites	Continuum mechanics for solids: tensor calculus and Einstein notation, Theory of elasticity (small strains), Isotropic and anisotropic constitutive laws, mechanics of plastic strain, plasticity criteria. Basic knowledge concerning experimental tests on conventional materials.
Teaching method	Lectures : 20 hours Applied Exercises : 8 hours Lab work : 8 hours Individual : 36 hours (20h lectures, 8h AE, 8h lab work)

Motivation

A strong knowledge of the mechanical behavior of biological tissues is required to understand the clinical issues for rehabilitation and design new prosthetic solutions.

Learning objectives

At the end, the students should:

- Be able to apply the theoretical principles of the continuum mechanics to study biological tissues
- Know the composition and structure of bone tissues
- Know the mechanical properties of bone tissues (constitutive laws, ranges)
- Know the mechanical properties of soft tissues
- Know the ethical principles to conduct research on animals, human bodies and human-beings
- Understand and explain the experimental issues specific to biological tissues
- Be able to comment and write a protocol to characterize biological tissues in response to specific hypotheses

Contents	Level of competency (4)
• Theory of elasticity (small strains and large strains)	3
• Anisotropic elasticity	2
• Hyperelasticity	2
• Multiscale aspects of biological tissues	1
• Experimental testing in biomechanics	2
• Apparent properties of hard tissues	2
• Mechanical properties of soft tissues	2

Literature	*Bone mechanics handbook* by Cowin (ISBN 9780849391170) Skeletal tissue mechanics by Martin, Burr and Sharkey (ISBN 0-387-98474-7) *Bones* by Currey (ISBN 0-691-12804-9) *Mechanics of Biological Tissue - Part IV: Biological tissues* by Holzapfel and Ogden (ISBN-13 978-3-540-25194-1)
Assessment	Written (2h)
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	E. DE BROSSES
More contact persons	A. BALDIT, E. DE BROSSES, C. LAURENT, P. LIPINSKI

Course title	**Prosthetic Device Design and Manufacturing**
Course Code	9KEL1M17
Field of study	Mechanics, Biomechanics
Offered	Autumn
ECTS-credits	5 ECTS
Language	English
Prerequisites	CAD software Manufacturing processes Material science Dimensioning
Teaching method	Lectures: 36 hours Applied Exercises : 2 hours Lab work: 24 hours Individual: 60 hours (30 lectures, 30h lab work)

Motivation

The motivation of this module is to provide knowledge on biomaterials and manufacturing processes in order to design new medical devices.

Learning objectives

This module is composed of 4 parts: Biomaterials, Prosthetic device design; Prosthetic device manufacturing, Design project.

The aims of the module are:

Biomaterials:

- to give definition and generalities about biomaterials
- to describe more precisely the third-generation implants (tissue engineering)
- to know what a polymer is and which polymer can be used for biomaterials

Prosthetic device design:

- to give the different steps of a standard device design and patient-specific device design
- to explain regulations concerning the device design

Prosthetic device manufacturing:

- to describe processes manufacturing used for polymers
- to describe the different technologies of additive manufacturing

Design project:

- to be able to design a new device corresponding to the proposed project

Contents	**Level of competency (4)**
• Biomaterials	2
• Tissue engineering	3
• Prosthetic device design	2
• Additive manufacturing	3
• Polymer science	2
• Conventional manufacturing processes	2

Literature	*Series on Biomaterials and bioengineering Vol. 1, An introduction to biocomposites* by Seeram Ramakrishna, Zheng-Ming Huang, Ganesh V Kumar, Andrew W Batchelor, Joerg Mayer (ISBN 1-86094-425-6) *Series on Biomaterials and bioengineering Vol. 2,Life-Enhancing plastics* by Anthony Holmes-Walker (ISBN 1-86094-462-0) *Additive manufacturing technologies* by Ian Gibson, David W. Rosen, Brent Stucker (ISBN: 978-1-4419-1119-3)
Assessment	1 Written exam (WE), 1 Project (P) to obtain a Final Ass. (0.5 WE+ 0.5 P)
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	C. DREISTADT
More contact persons	A. BALDIT, A.-S. BONNET, C. DREISTADT, G.DUBOIS, X.GODOT, P. LAHEURTE, C. LAURENT

Course title	**From Mechano-Transduction to Rehabilitation**
Course Code	9KEL1M18
Field of study	Mechanicals, Biomechanics
Offered	Autumn
ECTS-credits	1.5 ECTS
Language	English
Prerequisites	Structure of bone tissues, Behavior of biological tissues, Finite Element Method
Teaching method	Lectures: 8 hours Applied Exercises: 2 hours Lab work: 8 hours Individual: 18 hours

Motivation

To propose innovative therapeutic solutions for rehabilitation, it is necessary to make the link between mechanics and biology.

Learning objectives

At the end, the students should:

- understand the evolving behavior of bone tissues
- have knowledge about the link existing between cellular activities and modifications in biological tissues
- understand models simulating bone adaptation, healing and remodeling
- know the main solutions for bone reconstruction

Contents	Level of competency (4)
Introduction to adaptive behavior of biological tissues	2
Mechano transduction and cell differentiation	3
Bone growth, bone healing, bone remodeling	3
Bone remodeling mechanisms	3
Solutions for bone reconstruction	2
Trabecular bone remodeling and structural optimization	3

Literature	*Skeletal Function and Form* by D.R. Carter, G.S. Beaupré
Assessment	Written (2h)
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	Anne-Sophie BONNET
More contact persons	BALDIT Adrien, BONNET Anne-Sophie, DE BROSSES Emilie, GANGHOFFER Jean-François, NOWAK Michal

Course title	**Transversal Project**
Course Code	9KEL1M19
Field of study	Mechanics, Biomechanics, Biomimetics
Offered	Autumn
ECTS-credits	4 ECTS
Language	English
Prerequisites	Solid and fluid mechanics, biomimetics
Teaching method	Lectures: 6 hours Tutorials: 6 hours Practical: 32 hours Personal: 44 hours

Motivation

- Interest for scientific projects within a workgroup.
- Use all skills learned to fulfill a project answering a professional issue.

Learning objectives

At the end, the students should:

- be able to find information needed in scientific and technological documents,
- be able to use and apply all expertise learned in biomimetics and biomechanics,
- be able to work as a team,
- be able to manage a project.

Contents

Scientific document analysis (4h lectures / 8h tutorials) :

- Scientific articles
- Patents
- Standards

Transversal project (32h practical): Based on the overall courses done during the semester, a project is proposed to the students allowing them working as a team to answer an industrial need. All students' skills are required to work and succeed in a good and dynamic atmosphere.

Literature	Depending on the project
Assessment	2 reports and 2 presentations
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	BALDIT Adrien (baldit@enim.fr)
More contact persons	BALDIT Adrien, BONNET Anne-Sophie, DE BROSSES Emilie, DREISTADT Cynthia, FONCK-NUNEZ Marie

Course title	**The Multibody System Method Applied to the Human Body**
Course Code	9KEL1M20
Field of study	Mechanicals, Biomechanics
Offered	Autumn
ECTS-credits	3 ECTS
Language	English
Prerequisites	Mechanics: Basic knowledge concerning the kinematics of rigid body, the Newton's laws applied to rigid bodies, Theological models. Anatomy: Names of the limbs, joints and bony structures. Names of the anatomical directions and planes.
Teaching method	Lectures: 18 hours Applied Exercises: 20 hours Lab work: Individual: 38 hours (18h lectures, 20h AE)

Motivation

The analysis of human motion is a method widely used in different technological fields such as for medical applications, in sport, robotics or entertainment.

Learning objectives

At the end, the students should:

- Write and solve the equations corresponding to a human motion
- Understand the usefulness of the "frame of interpretation"
- Know the hypotheses made for the analysis of human motion
- Understand the usefulness of standardization for the definition of anatomical frames
- Analyze the results of a kinematic study on human body
- Write the Newton's laws for dynamic studies on human body
- Know the models for the determination of the body segmental inertial parameters
- Use of the kinematic data for the inverse dynamics method
- Know the physiological behavior of muscles
- Use rheological models to describe the mechanical behavior of muscles
- Understand and explain the principles of EMG and sEMG measurement

Contents	**Level of competency (4)**
• Motion analysis of human body (kinematics and dynamics)	3
• Posture and muscles	2

Literature	*Kinematics of Human Motion* by V. Zatsiorsky (ISBN-13:978-0880116763) *Kinetics of human Motion* by V. Zatsiorsky (ISBN-13:978-0736037785) *Biomechanics of the Musculo-skeletal System* by Nigg B.M. & Herzog W. (ISBN-13: 978-0470017678)
Assessment	Written (2h)
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	E. DE BROSSES
More contact persons	E DE BROSSES, W. WOJNICZ

Course title	Biomimetics
Course Code	9KEL1M21
Field of study	Biomimetics and Locomotion
Offered	Winter
Coefficient	4
ECTS-credits	4 ECTS
Language	English
Prerequisites	None
Teaching method	Lectures : 20 hours Tutorials : 4 hours Practical : 20 hours Personal : 40 hours

Motivation: Student perception of biomimetics is crucial to develop new ideas and concept to design biomechanical systems or devices.

Learning objectives: It will start with knowledge about the development of biomimetics and its use since middle age allowing having reflection about ideas from nature.
Secondly, the students will be introduced to bio fluid mechanics applied to nature. Fundamental equations of fluid mechanics will be taught and followed by numerical application thanks to computational fluid dynamics.

Contents:
The course will give a short introduction into the field of biomimetics: What is biomimetics – and what not, the 3-criteria-definition, biology push – technology pull, application areas. Short excursion into history: from the middle age to the year 2000. The biomimetical working process (problem definition, morphologi- cal / Zwicky box, weighting of criterias, best model, plan B). Where the models / ideas came from: some biology (phylogenetics, systematics, morphology, locomotion of animals). Selection of examples from current topics in biomimetics (functional surfaces, bio-materials, ultraleight structures, fluid dynamics and MAVs / AUVs), the course will end with a short workshop ”Is there an idea from nature to. . . ?”.

With various examples the introduction to bio fluid mechanics gives insight of fluid mechanical phenomena in nature which have been transferred to technical applications. To understand and to apply computational fluid dynamics the knowledge and understanding of the fundamental equations of fluid mechanics are essential. Therefore, the continuity and Navier-Stokes equations are derived. To build up a simulation case further knowledge is required about the numerical treatment of the fundamental equations. This is delivered in numerical methods in fluid mechanics. After a short introduction to Ubuntu the hands on application starts with a simple case of computational fluid dynamics which gets more complex further on. As software, the open source code OpenFOAM is applied.

Literature	- *Turbulence in Fluids* (4^{th} edition), M. Lesieur, Springer, 2008. - *Analysis of Vertebrate Structure* (5^{th} edition), M. Hildebrand and G. Goslow, 2002. - *An Introduction to Fluid Dynamics*, G. K. Batchelor, Cambridge Mathematical Library, 2000.
Assessment	The Assessment consists of a project report of 3000 words, written in English. The project deals with an improvement of a fluid mechanical related technical application using biomimetic technique. Therefore, the original and the modified object are investigated by numerical fluid simulation. The object is chosen by the students.
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	BALDIT Adrien - adrien.baldit@univ-lorraine.fr

Course title	**Biomedical Basic Knowledge**
Course Code	9KEL1M22
Field of study	Medical science, Biomechanics
Offered	Autumn
ECTS-credits	2.5 ECTS
Language	English
Prerequisites	None
Teaching method	Lectures: 24 hours Applied Exercises: Seminars and visits: 10h Individual: 24 hours (24h lectures)

Motivation:
Bases of anatomy, histology and implantology are necessary for the design of medical devices

LearnLearning objectives

- To give engineering students basic notions about anatomy of head and neck
- To give engineering students basic notions about histology
- To give engineering students basic notions about medical imaging
- To provide clinical examples of craniomaxillofacial reconstruction
- To introduce engineering students to an understanding of dental implantology and the widening of knowledge in this discipline.
- To draw attention to the biomechanical aspects of dental implant complications.

Contents	**Level of competency (4)**
Anatomy, Histology	2
Craniomaxillofacial reconstruction	2
Dental implantology	3
Seminars and visits	1

Literature	Dental Implant Prosthetics by C.E. Misch. Implant Overdentures. The Standard of Care for Edentulous Patients by J.S. Feine, G.E. Carlsson. Manual of Oral Implantology from C. Maiorana, M. Beretta M, Implant Therapy. Clinical Approaches and Evidence of Success Volume 2 by M. Nevins, J. Melloning. Tissue Engineering. Applications in Oral and Maxillofacial Surgery and Periodontics", Second Edition by S.E. Lynch, R.E.Marx, M. Nevins, L.A. Wisner-Lynch.
Assesement	1 project
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	Anne-Sophie BONNET
More contact persons	Emilie DE BROSSES, Malgorzata NATHER Narcisse ZWETYENGA

Course title	Simulation with Star-CCM+
Course Code	9KEL1M25
Field of study	Computational Fluid Dynamics
Offered	winter term
ECTS-credits	3.5 credit ECTS
Language	English
Prerequisites	Fluid dynamics Thermics
Teaching method	Lectures: 0h Tutorials: 16h Practice: 48h Personal: 12h
Motivation - Setup a CFD simulation ; - Evaluate drag forces on a vehicle; - Evaluate a fluid velocity, pressure, temperature along a streamline ;	
Learning objectives - Mesh and model setup ; - Warnings about CFD software pitfalls and limits ; - Analyse and validate a CFD simulation result	
Contents Using Star-CCM+ software : - Gas or water pipe flows (laminar, turbulent) ; - Wind tunnel simulations ; - Air/Water heat exchanger ;	
Literature	- PDF Tutorials on Agora ; Star-CCM+ help files ;
Assessment	3 simulations to achieve
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	F. Rimbert

Course title	**Electric Energy Transport**
Course Code	9KEL1M27
Field of study	Electrical Engineering
Offered	Winter term
ECTS-credits	1
Language	English
Prerequisites	To get the most benefit from this course, attendees should have: ● An understanding of complex numbers associated with sinusoidal electric voltages and currents ● An understanding of Kirchhoff circuit Law ● A basic understanding of electric power
Teaching d	Lectures: 10 hours Tutorials: 8 hours Practical: none Personal: 12 hours The students will experiment the *learning-by-doing* way of working. They'll be asked to work on a Portfolio to defend in front of a jury. In this course a portfolio is a collection of problems to be solved by the students and presented for evaluation. Students will work in pairs and each pair of students will have a set of two different problems: three-phase AC circuit and power line transmission. During the seminars they'll work on their portfolio and outside the class 12 hours of personal workload is expected. Every student will defend his job in front of a jury at the end of the course

Motivation

Growing populations and industrializing countries create huge needs for electrical energy. Transmitting electricity over
e involves energy loss. So, with growing demand comes the need to minimize this loss to achieve two main goals: reduce
e consumption while delivering more power to users.

This course addresses the need to minimize the energy loss and the ways to achieve it. It'll give the students a fresh look at
damentals of electric energy transport and a new way of working

Learning objectives

When the course is completed, students are expected to be able to:

- Describe Electric Power Grids structure
- Explain the need for high voltage transmission and reactive power compensation
- Understand how Transmitted Power over the line and Voltage Drop constraints are related
- Master basic calculation associated with sinusoidal electric voltages and currents
- Explain the pros and cons of the Portfolio method they went through

Contents

- Basics of Electric Energy Transport
- Complex numbers associated with sinusoidal electric voltages and currents reminder.
- Electric power: active, reactive and apparent
- Three-phase AC circuit (circuit analysis)
- Power line transmission (efficiency, voltage drop, reactive power compensation)

Literature	● Foundations of Electrical Engineering. JR Cogdell, Prentice Hall. Chapters 1, 4, 5 and 6 ● Schwartz & Oldham, Electrical Engineering an introduction, second edition, Oxford. Chapters 6 and 7 ● Electrical Machines, Drives and Power Systems, fourth edition. Theodore Wildi, Prentice Hall. Chapters 2, 7, 8 and 25 ● Electric Power Distribution System Engineering. Turan Göenen, CRC Press. Chapter 7 ● Electric Energy, an introduction. Mohamed A. El-Sharkawi, CRC Press. Chapters 2,7 and 8
Assessment	The learners will have to produce a written Portfolio in order to demonstrate the competencies they master and defend it in front of a jury.
Grading	According to the grading scale of ENIM
Re-examination	No
Contact person	NOWAK Thierry, email: **thierry.nowak@univ-lorraine.fr**

<table>
<tr><td>Course title</td><td>Integrated Logistics Support in Systems Engineering</td></tr>
<tr><td>Course Code</td><td>9KEL1M98</td></tr>
<tr><td>Field of study</td><td>Systems Engineering</td></tr>
<tr><td>Offered</td><td>Fall term</td></tr>
<tr><td>Coefficient</td><td>2</td></tr>
<tr><td>ECTS-credits</td><td>3 credit ECTS</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Prerequisites</td><td>Systems analysis and modeling, Functional analysis and modeling, Basics in statistics and probability, Industrial internship</td></tr>
<tr><td>Teaching method</td><td>Lectures: 8 h
Tutorials: 8 h
Projects: 8 h
Personal: 20 h</td></tr>
<tr><td colspan="2">Motivation
The development of complex industrial systems requires knowledge to better specify their safe operation requirements, to anticipate logistical needs in material, human, data and information, in phase of acquisition, and to better manage their after-sales services. This aims to ensure their competitive operational efficiency. The concepts learned in this course are useful for engineers who are willing to participate effectively in the development of such integrated systems, starting from design. The acquired skills are a real added value for companies looking to develop integrated and competitive equipment with low overall cost of ownership and highly available during operation.</td></tr>
<tr><td colspan="2">Learning objectives
to understand the analysis and design methods of complex systems
to model and evaluate the performance of a complex system and its support system
to allocation dependability requirement to a system to be designed of acquired
to model and optimize a logistics and after-sale service
to size and optimize the inventory of spare parts and tooling
to analyze and anticipate an overall cost of ownership</td></tr>
<tr><td colspan="2">Contents
General introduction to ILS (Integrated Logistics Support)
Optimization of RAMS requirements allocation in design phase
Maintainability analysis and prediction in design phase
Features for dominant solutions selection
Design for Supportability
Logistic Information System</td></tr>
<tr><td>Literature</td><td>- B. Blanchard and Fabrycky, System Engineering and Analysis, Prentice Hall, 1998.
- M. Pecht, Product reliability, maintainability, and supportability handbook. CRC Press, 2009.
- B. Dhillon, Life cycle costing: techniques, models and applications. Routledge, 2013.
- J. Knezevic, Reliability, maintainability, and supportability: a probabilistic approach. McGraw-Hill Companies, 1993.
- Díaz, V. González-Prida, and A. Crespo Márquez. “After–sales Service of Engineering Industrial Assets. Springer,</td></tr>
<tr><td>Assessment</td><td>Examination (30%), Home work (20%), Collaborative project report (30%), Oral defense (20%)</td></tr>
<tr><td>Grading</td><td>According to the grading scale of ENIM</td></tr>
<tr><td>Re-examination</td><td>Yes</td></tr>
<tr><td>Contact person</td><td>Prof. Kondo H. Adjallah</td></tr>
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