Syllabus
Master de Mécanique
Parcours type Ingénierie 4.0 en Mécanique et Matériaux
Research dedicated Orientation: Mechanics of Materials, Structures and Process

2024/2028

Orientation : MMSP, Metz

UNIVERSITÉ DE LORRAINE | UFR MATHÉMATIQUES INFORMATIQUE MÉCANIQUE ET AUTOMATIQUE

Competences and skills that will be acquired and learning results (at the end of the master degree):

General Skills

Skill 1 To solve a mechanical problem with its boundary conditions, to propose a model as simple as possible and to conduct a critical analysis of the results.	*Level 4*
Skill 2 To apply the usual concepts of various scientific fields of a technical subdomain to solve a complex problem, including a problem of design or engineering.	*Level 3*
Skill 3 To adopt free or commercial softwares, to solve physical problems.	*Level 4*
Skill 4 To develop capability to work in a team, with autonomy and also with colleagues for the benefit of the project.	*Level 4*
Skill 5 To know how to communicate in both written and spoken French and English and become a team manager (to plan, organize, create and conduct meetings in an efficient way).	*Level 3*

Specific skills for the different subdomains of the master degree:

Skill 6 To validate a model by comparing its predictions with experimental results and discuss its validity range.	*level 3*
Skill 7 To Solve problems to develop new knowledge and new procedures and integrate knowledge from different fields	*Level 2*

Skill 8 To identify, based on the well established skills in mechanical engineering, material sciences, salient simulation softwares and to propose to propose their uses in the industry.	*Level 4*

Program of the 2nd year of the master degree MMSP

SEMESTER 9

ORI Mécanique Matériaux Structures et Procédés
CHOI CHOI 1
BC 5: Strengthening the professional perspectives
UE 900 Internationalization and project
EC01 Internationalization
EC02 ORION excellence Practical Works Part 1
UE 901 Integrative project or Apprenticeship
BC 12: Modeling material behaviors
UE 920 Experimental methods in solid mechanics
UE 921 Mechanical behaviour of materials
UE 922 Thermomechanical behavior of heterogeneous materials
UE 923 Continuum mechanics
UE 924 Structural mechanics and finite element analysis
UE 927 Deformation Mechanisms and microstructure
CHOI options
BC 13: Building advanced approaches for extreme loadings
UE 925 Numerical methods in computational mechanics
UE 928 Fracture and Damage mechanics
UE 929 Mechanics of composite materials and structures
UE 930 Control and damping of vibrations
UE 931 Material characterization and modeling in dynamic loading
UE 932 Machining Processes: Modeling and Experimentation
UE 938 Metal forming

SEMESTRE 10

SEMESTRE 10
STG UE101 5-month Internship in research laboratory academia or industry

Detailed Program

UNIVERSITÉ DE LORRAINE | UFR MATHÉMATIQUES INFORMATIQUE MÉCANIQUE ET AUTOMATIQUE

The course syllabus and the academic weekly planning may change due academic events or other reasons.

Name of the coordinating teacher may change.

Note that each course may not open each semester.

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM20

Nom complet de l'UE : 900 Foreign language, internationalization and research

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Eric Fleury eric.fleury@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 20h, Nombre de crédits ECTS : 5

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	EqTD
EC01 Scientific communication, internationalisation	6000	20	30
EC02 ORION excellence Practical works	6000	0	15

Descriptif
The course will have two parts: one is dedicated to explain how to write a peer review article and the second concerns ORION excellence Practical Works.

Prerequisite
None

Learning results
The student will be able to understand and write a paper in English.

Competences and skills
Skill 4: level 4
Skill 5: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM20

Nom complet de l'UE : 901 Integrator or work-study Project

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Michael Brun michael.brun@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : HPRJ, Nombre de crédits ECTS : 4

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Français ou Anglais (French or English)

Enseignements composant l'UE	CNU	CM	TD	TP	TPL	EqTD	HPRJ
UE901 projet intégrateur alternance	6000						x

Descriptif

The course is devoted to the initiation to Research. The goal is to understand, detail and present a scientific paper (small lecture in English of 15 minutes), in accordance with the domains of interest of researchers involved in the Master 2 MMSP.

Additional works (analytical/numerical/experimental works), with the help of the referent researcher, in relation to the proposed scientific paper, are expected in order to evaluate the involvement in the Research Project.

A scientific report will be written in English during the project.

Prerequisite

None

Learning results

The student will be able to apply all the knowledge of the semester to solve a research project.

Competences and skills

Skill 4: level 4
Skill 5: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM12

Nom complet de l'UE : 920 Experimental Methods in solid mechanics

Composante de rattachement : ENSAM / FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Fodil MERAGHNI
fodil.meraghni@ensam.eu

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD	DLOC
920 Experimental Methods in solid mechanics (ENSAM)	6000	20	10	40	ENSAM

Descriptif

This course is an introduction to methods and tools specific to the implementation of experimental approaches in solid mechanics. It aims to provide students with basic scientific knowledge to define and implement a consistent experimental approach dedicated to the characterisation or identification of the mechanical behavior of materials and structures. In the first part, the course covers the main aspects inherent in the measurement and experimental data processing particularly in terms of measurement errors. The second part is devoted to presenting examples of experimental techniques and their recent advances in the characterisation particularly for mechanical tests. Besides the description of these techniques, we aim to show, through research studies, the interest of the experimental method to build, to identify or to enrich the modeling of solid state mechanics at different scales: micro-macro-meso levels. A part of the course is devoted to optical microscopy and scanning electron. Some experimental methods and techniques implemented for the study of fragile and ductile materials are included in the course.

Prerequisite

Mechanical bases of solids - Behaviour of Materials

Learning results

The course represents an introduction for students to the methods and tools of research for the implementation of experimental approaches dedicated to the construction and identification of solid mechanics models.

Competences and skills

Skill 2: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM13

Nom complet de l'UE : 921 Mechanical behavior of materials

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Abdelhadi Moufki abdelhadi.moufki@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais /english

Enseignements composant l'UE	CNU	CM	TD	EqTD
921 Mechanical behaviour of materials	6000	20	10	40

Descriptif

1. Elastic-viscoplastic behavior through classical mechanical models (Maxwell, Kelvin, Zener)
2. Elastoplasticity
   - Plasticity criteria (Tresca, Mises, Hill, Schmid)
   - Prandtl-Reuss model (J2 theory)
   - Incremental relationship between stress and strain hardening in general
3. Viscoplasticity
   - viscoplastic
   - crystalline viscoplasticity
4. Elastoviscoplasticity
5. Behaviour of Nanocrystalline materials

Prerequisite

General notion of Materials Science and continuum mechanics

Learning results

To develop theoretical knowledge and computational tools for the mechanical behavior of materials

Competences and skill

Formulate a mechanical problem with its boundary conditions, address it in a simple manner, solve and conduct a critical analysis of the result

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM14

Nom complet de l'UE : 922 Thermomechanical behavior of heterogeneous materials

Composante de rattachement : ENSAM FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Georges Chatzigeorgiou georges.chatzigeorgiou@ensam.eu

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD	DLOC
922 Thermomechanical behavior of heterogeneous materials	6000	20	10	40	ENSAM

Descriptif

The goal is to provide a deep understanding in the behavior of homogeneous and heterogeneous materials under thermomechanical loading conditions.
The following topics will be presented:

Recall of continuum mechanics principles
- kinematics, kinetics, conservation laws,
- thermoelasticity

Thermodynamics of irreversible processes

- Thermodynamics,
- Dissipation, energy balance,
- Example with plasticity (isotropic/kinematic hardening)

Heterogeneous materials : Micromechanics
- nature of heterogeneities
- classical micromechanics concepts (average theorems, Hill-Mandel)
- Eshelby inclusion problems, Eshelby-based approaches (Mori-Tanaka, self consistent)
- other homogenization schemes
- effective thermoelastic properties

Martensitic transformation
- The case of single crystal

The case of polycrystal
shape memory alloys under thermomechanical loading

Prerequisite

Background in continuum mechanics, in mechanics of materials.
Basic knowledge in thermodynamics

Learning results

With the present course, the student will be able to :

- derive the constitutive laws and evolution equations for dissipative materials using the thermodynamic principles
- identify effective elastic and thermal properties of composites with random structure using micromechanics (Eshelby-based methods), or with a periodic microstructure (laminates)
- understand the effect of martensitic transformation and the behavior of shape memory alloys
- compute the stress-strain response in simple problems of homogeneous and heterogeneous materials.

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 5: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM15

Nom complet de l'UE : 923 Continuum mechanics

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Sébastien Mercier
sebastien.mercier@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
923-Continuum mechanics	6000	20	10	40

Descriptif

The goal is to provide a deep understanding of fundamental concepts in the description of motion of deformable bodies.
The following topics will be presented :

Kinematics of continuum medium
- Lagrangian/ Eulerian motions
- Deformation gradient, polar decomposition, finite strain
- Infinitesimal deformation, small strain, compatibility conditions
- Transport relations

Description of internal forces
- Cauchy stress tensor, PK stress tensor

Conservation laws

Constitutive models
- Thermodynamics principle,
- frame indifference

Mechanics of elastic solids
- Linear elasticity,
- Non linear elasticity

Prerequisite

Background in continuum mechanics, in mechanics of materials.

Learning results

With the present course, the student will be able to :

- describe motion, finite deformation, stresses and forces in a continuum medium
- derive equations of motion and conservation laws for a medium
- understand various constitutive models
- solve simple boundary value problems for solids.

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 5: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM16

Nom complet de l'UE : 924 - Structural mechanics and finite element analysis

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Hamid Zahrouni hamid.zahrouni@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
924 - Structural mechanics and finite element analysis	6000	20	10	40

Descriptif

This course aims to present the fundamental concepts of structural mechanics and numerical simulation of deformable solids. Variational principles of mechanical problems are presented. Principle of virtual power, potential energy, complementary energy theorem. Applications to beam models and to three dimensional elasticity. Finite element method considering various types of structural elements. Numerical methods for nonlinear problems, resolution techniques: Newton Raphson, Asymptotic Numerical Methods. Application to nonlinear models as contact mechanics in the finite element framework, nonlinear elasticity including large displacements and rotations, nonlinear constitutive relations, instability and buckling phenomena, steady and transient problems.

Prerequisite

Background in continuum mechanics, in mechanics of materials and in finite element method.

Learning results

With the present course, the student will be able to :

- Formulate a mechanical problem using variational principles,
- Solve nonlinear problems with adapted techniques,
- Formulate and solve buckling problems

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 3: level 4

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM19

Nom complet de l'UE : 927 Deformation Mechanisms and microstructure

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Eric Fleury eric.fleury@univ-lorraine.fr

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
927 Deformation mechanism and microstructures	3300	20	10	40

Descriptif

- Complements on Geometric crystallography (symmetry point group) and introduction to the concept of crystallographic texture (stereographic projection, crystallographic orientation, representation of the ODF and elementary calculations)
- Mechanisms of plastic deformation, strengthening mechanism, microstructural evolution during the deformation
- Recovery, recrystallization and grain growth

Prerequisite

Elementary geometric crystallography (Bravais lattice, crystal symmetry)
General notion of Materials Science

Learning results

Understanding and mastering the basic mechanisms of plastic deformation and recrystallization in polycrystalline materials / Effects on microstructure evolution during thermomechanical treatment and its effect on the mechanical properties

Competences and skills

Formulate a mechanical problem with its boundary conditions, address it in a simple manner, solve and conduct a critical analysis of the result

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM17

Nom complet de l'UE : 925 Numerical methods in computational mechanics

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Michael Brun michael.brun@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
925 Numerical methods in computational mechanics	6000	20	10	40

Descriptif

The course presents detailed and advanced numerical strategies for solving dynamic problems. It includes the variational formulation for the space discretization as well as the time discretization using different time integration schemes. Stability, order of accuracy and convergence associated with the numerical methods are of interest. Programmation in Matlab environment in order to solve simple static and dynamic probelms allows the students to improve their mechanical modeling skills when using industrial Finite Element codes.

I. Strong form of Partial Differential Equations in Mechanics

Strong form for the static equations and equations of motion
Partial Differential Equations for structural elements with kinematic assumptions (bar, beam, shell elements)

II. Weak form for the spatial and time discretization

Virtual Work Principle
Stationary-Action Principle

III. Spatial Discretization

1. Finite Element Method

Displacement approximation
Isoparametric elements
Order of the polynomial approximation (P1, P2)
Gauss integration
Building of the Mass matrix, Stiffness matrix, Damping matrix and nodal Force vector
Discrete equations for the statics and dynamics
Accuracy and order of convergence in terms of the finite element size
Treatment of Dirichlet boundary condition with Lagrange multipliers

2. More modern discretization methods

Spectral elements: High order Lagrange polynomials and Gauss-Lobatto-Legendre integration in the case of quadrilateral and hexaedral elements

Isogeometric Analysis: B-spline approximation of the displacement in the case of quadrilateral and hexaedral elements

IV. Time Discretization

Generalities on time integration schemes: Stability, consistency, accuracy and order of convergence in terms of the time step size
Time integration schemes for structural dynamics and wave propagation in solids: Euler, Newmark, Explicit (Central Difference scheme), Implicit (Constant Average Acceleration), schemes with numerical damping.

V. Transient problems for structural dynamics

Modal analysis for linear dynamics and Modal Transient Response analysis
Direct Explicit and Implicit time integration of the discrete equation motion
Non-linear dynamics: Case of nonlinear material law, iterative methods (Newton-Raphson) with Implicit time integration and Explicit analysis for nonlinear dynamics with frictional contacts

Prerequisite

Background in continuum mechanics and basics in the Finite Element Method.

Learning results

Thanks to the present course, the student will be able to :

- Understand the salient points of numerical strategies for solving quasi-static and dynamic problems
- Program the Finite Element Method in statics and dynamics in the Matlab environment

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 3: level 4

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM21

Nom complet de l'UE : 928 Fracture and Damage Mechanics (CMGS)

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Cristian Dascalu cristian.dascalu@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
928-Fracture and Damage Mechanics	6000	20	10	40

Descriptif

The course presents the basics of fracture and damage mechanics and fatigue of materials. The topics covered by the lectures are:

Linear elastic fracture mechanics
- Singularities, asymptotic analysis
- Stress Intensity Factors
- Energy Release Rate and J integral
- Crack propagation criteria

Dynamic fracture mechanics

Elastic-plastic fracture mechanics
- Dugdale and cohesive-zone models
- HRR fields
- J-controlled crack propagation

Damage mechanics
- Micromechanics of damage
- Brittle damage laws
- Ductile and creep damage

Fatigue
- Cyclic stress history, Wöhler curves
- Damage models for fatigue
- Fatigue crack growth

Prerequisite

Background in continuum mechanics and mechanics of materials.

Learning results

The student will have a global view of the failure theories for materials starting from distributed damage, initiation of cracks and their growth up to ultimate failure of mechanical structures. He/she will know how to choose the appropriate modeling depending on the type of loading or the material behavior and will be able to solve fracture and damage problems by analytical methods or have the necessary background for their implementation in numerical codes.

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 5: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM22

Nom complet de l'UE : 929 Mechanics of composite materials and structures

Composante de rattachement : ENSAM / FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Fodil MERAGHNI
fodil.meraghni@ensam.eu

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD	DLOC
929 Mechanics of composite materials and structures	6000	20	10	40	ENSAM

Descriptif

The course aims at providing students with manufacturing knowledge and theoretical background to choose a fabrication process and to design laminated polymer matrix composites. In the first part, the course covers an introduction to composite materials in terms of reinforcement architectures and matrix types, presents the main manufacturing process and the relationship between a process and the subsequent performances of the composite. The second part of the course provides analytical methods for the computation of the effective properties of composites and laminated materials. This part aims at developing an understanding of the linear elastic analysis of composite materials including anisotropic material behavior and the analysis of thin laminated plates.

The following topics will be presented:

Motivations - examples of composites.
Nature and types of reinforcement.
Fabrication process for fibrous reinforced composites.
Mechanical properties of the plies.
Sandwich materials.
Specific design rules for composites
Classical Laminate theory
Mechanical behavior of laminated composites.
Elastic constants of a ply in arbitrary directions.
Response of laminated composite (in-plane and out of plane coupling)
Anisotropic failure criteria (Tsai-Wu, Hill, generalized Von-Mises …)
Composite beams under combined loading (bending and torsion).
Hands-on and case studies using elamx and Abaqus
Introduction to homogenization theory: computation of effective moduli for periodic and random media.
Introduction to the mechanics of generalized continua.

Prerequisite
Background in continuum mechanics, in mechanics of materials.

Learning results
With the present course, the student will be able to:
- Compute the effective thermomechanical properties of stratified materials.
- Design stratified materials based on Hill's criterion.
- Solve problems of composite beams.
- Determine the effective properties of periodic elastic composites.

Competences and skills
Skill 1: level 4
Skill 2: level 3
Skill 5: level 3

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM23

Nom complet de l'UE : 930 Control and damping of vibrations

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : El Mostafa Daya
el-mostafa.daya@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
930-Control and damping of vibrations	6000	20	10	40

Descriptif

The goal of this course is to study the vibration of mechanical systems and structures. Indeed, the control and the damping of vibrations are still important tasks to design structures in many industrial domains such as aerospace, automobile, civil engineering,..This will give comprehensive skills to analyze the linear and nonlinear vibrations, especially on basic techniques of resolution and modeling.

The following topics will be presented:

- Linear vibrations analysis,
- Effects of the nonlinearities in structural dynamics,
- Study of Duffing oscillator, Amplitude equation and backbone curves.
- Nonlinear vibrations of beams,
- Methods and modal analysis in nonlinear structural dynamics,
- Active control and passive damping of vibrations

Prerequisite

Background in continuum mechanics, in structural mechanics and a preliminary course in structural dynamics

Learning results

With the present course, the student will be able to:

- describe different parameters influencing the vibration problems (frequency, modes, damping coefficient)
- formulate and solve the vibration problems
- understand the influence of nonlinearities in vibration problems

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 3: level 4

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM24

Nom complet de l'UE : 931 Material characterization and modeling in dynamic loading

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Sébastien Mercier
sebastien.mercier@univ-lorraine.fr
In collaboration with CEA GRAMAT

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
931 Material characterization and modeling in dynamic loading	6000	20	10	40

Descriptif

The goal is to provide a deep understanding of fundamental concepts in the description of material behavior under dynamic loading and all processes related to strain rate effect and wave propagation.
The following topics will be presented:

Constitutive relations
- Phenomenological approach
- Semi-physical approach
- Physical approach
- Thermoplastic behavior
- Thermoviscoplastic behavior

Experimental techniques
- SHP technique
- Taylor test
- Plate impact test

Prerequisite
Background in continuum mechanics, in mechanics of materials.

Learning results
With the present course, the student will be able to:
- Model material behavior for a large range of temperatures and strain rates
- Analyze elastic and plastic behavior
- Use the correct technique to analyze material behavior under dynamic loading
- Have a correct understanding on mechanical measurements and effects disturbing measurements.

Competences and skills
Skill 1: level 4
Skill 2: level 3
Skill 3: level 4

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM25

Nom complet de l'UE : 932 Machining Processes: Modeling and Experimentation

Composante de rattachement : FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Abdelhadi Moufki abdelhadi.moufki@univ-lorraine.fr

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD
932-Machining Processes: Modeling and Experimentation	6000	20	10	40

Descriptif

The aim is to analyze and to model the thermomechanical mechanisms of the chip formation process during cutting. This allows to characterize the interaction between the cutting tool, work material and the cutting process. Different industrial applications will be studied in the case of advanced cutting processes such as deep drilling, broaching and gear hobbing.

To achieve this purpose, several approaches will be provided:

- Mechanistic and experimental methods
- Analytical models
- Numerical simulations

Prerequisite

Background in continuum mechanics, and material sciences.

Learning results

With the present course, the student will be able to :
- use his background in continuum mechanics, in mechanics of materials for modeling in machining processes.
- analyze how the cutting conditions affect the chip formation mechanisms, tribological conditions, workpiece surface integrity, tool wear and tool life.
- estimate the cutting forces and the tool temperature.

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 3: level 4
Skill 8: level 4

Mention et/ou parcours dont relève cette UE : S&T_Master Mécanique

Code Apogee de l'UE : 9WUJAM31

Nom complet de l'UE : 938 Metal forming

Composante de rattachement : ENSAM / FB0 - UFR MATHEMATIQUES INFORMATIQUE MECANIQUE

Nom du responsable de l'UE et adresse électronique : Farid Abed-Meraim farid.abedmeraim@ensam.eu

Semestre : 9

Volume horaire enseigné : 30h, Nombre de crédits ECTS : 2

Volume horaire travail personnel de l'étudiant : 30h

Langue d'enseignement de l'UE : Anglais / English

Enseignements composant l'UE	CNU	CM	TD	EqTD	DLOC
937i Forming Processing	6000	20	10	40	ENSAM

Descriptif

Classification of forming processes – Physics and modeling of plasticity in metal forming (from single crystals to polycrystals) – Crystallographic texture analysis –Plastic flow of anisotropic materials – Finite deformations and material objectivity –Limit analysis and analytical methods – Presentation of major processes: rolling, forging, polymer processing, sintering, glass forming, deep drawing, high-speed machining – Finite element method and forming processes – Damage, plastic instabilities and prediction of sheet metal formability.

Prerequisite

Background in continuum mechanics and rheology of materials.

Learning results

With the present course, the student will be able to :

- classify a forming process,
- formulate the nonlinear problem,
- take into account contact, friction, nonlinear constitutive laws, anisotropy, instability…
- solve the resulting problems using industrial codes

Competences and skills

Skill 1: level 4
Skill 2: level 3
Skill 3: level 4