University of Southern Brittany (UBS)
École Nationale Supérieure de Techniques Avancées (ENSTA)
National Engineering School of Brest (ENIB)
University of Western Brittany (UBO)
Institut National des Sciences Appliquées Rennes (INSA Rennes)

Master of Design Engineering

Mechanics, Materials and Civil Engineering

Objectives

This pathway offers opportunities immediate professional integration after the Master's degree, as well as doctoral studies.

Graduates who choose to enter the workforce immediately are offered a wide range of jobs. Most R&D engineers specializing in the mechanics of materials and structures

For those who choose to pursue a doctorate, they can also apply for teaching-research positions in higher education or research positions in an organization (e.g., CNRS) upon completion of their doctorate.

Skills acquired

Based on a generalist training in the field of mechanics, this high-level course aims to give students a perfect command of the technical aspects of the implementation, control and monitoring of materials, as well as the modern tools of modeling and numerical calculation of structures. In particular, the course aims to provide students with a thorough understanding of the behavior and durability of materials, criteria for choosing structural materials, and numerical methods for calculating structures.

Access conditions

Access to the 2(nd) year of the Master's program is open to students with Bac+4 in the field of mechanics. The Master's program is taught in French, at a level equivalent to B2

Application

The number of places is limited to 30 students for this course. ENIB does not offer the M1 course, and only receives applications for M2. The admission decision is made after examination of the applicant's file.

Recruitment procedure :

Application form, CV, covering letter, copies of diplomas and transcripts (post-baccalaureate years)+ interview (if required)

Internship

Mandatory long-term internship (4 to 6 months)

The internship can be carried out in a university laboratory, a public research center or a corporate R&D

department. A written report and oral presentation are required before the Master's jury.

- Start date: March-April
- Duration: 4 to 6 months (minimum 16 weeks

Further studies

This course is undifferentiated (research and professional) and is designed so that graduates of the MMGC Master's program can enter the professional world directly, or continue their studies to prepare a doctorate for those intending to work in research.

Part of the projects are geared towards issues faced by companies in the sector, while another part focuses on more upstream topics. Over the course of their entire career, students are exposed to both types of problem.

Each year, the various research teams at the Institut de Recherche Dupuy de Lôme (IRDL, UMR CNRS 6027) offer academic or industrial thesis topics to graduates of this Master's program.

Professional integration

Graduates of the MMGC Master's program can work the following sectors:

Transport, Energy, Mechanical Engineering, Shipbuilding, Public Works, ...

They can be employed in the following positions:

Design project manager, Design and development engineer, Design-research-development manager, Researcher, Lecturer-researcher (after doctorate and competitive examination).

Teaching environment

The course has several well-equipped classrooms, with testing and characterization machines on the one hand, and industry-specific software on the other. Emphasis is placed on projects and student autonomy. The course is supported by a leading laboratory in the field of mechanics of materials and structures (IRDL, UMR CNRS 6027), which ensures that students benefit from teaching by research professors who are up to date with the latest technologies, as well as internship and thesis opportunities. Engineers from the world of business also contribute to the training program, providing additional insights.

Helping you succeed

The classes in this program are of a human scale, which facilitates exchanges with professors and means that students benefit from better supervision.

Practical info

- **Brest National Engineering School (ENIB)**
- Open to sandwich courses
- **Teaching location :** Brest
- **Contacts :**
  Training Manager
  Nahiene Hamila
  Registrar's Office - Master IdC
  +33 (0)2 98 05 66 16 (or 00)
  scolarite@enib.fr

Program

The course is organized over 2 semesters: S9 and S10.

Semester S9 (36 ECTS credits) comprises 6 compulsory scientific units (see table below).

Semester S10 (24 ECTS credits) is devoted to the research internship (4 to 6 months).

The Master's degree is awarded to any student who has obtained 60 ECTS credits by direct validation of UEs.

Because of the difference in ECTS credits allocated to semesters S9 (36 credits) and S10 (24 credits), in calculating the overall average, the average for semester S9 is weighted by a coefficient of 0.6, and the average for semester S10 (research internship) is weighted by a coefficient of 0.4. At the end of S9, an overall average of over 10 for all 6 UEs gives access to S10. Without this condition, students will not be able to start S10.

Semester S9	
EU-1 Finite element method for linear problems and non-linear	**Number of ECTS :** 6 **Prerequisites:** Continuum Mechanics; Strength of Materials; Finite Elements in linear elasticity **Objective:** The aim of this course is to study the assumptions, approximations and numerical techniques used in finite element codes to solve linear and non-linear problems. The aim is to cover the choice of parameters for finite element modeling, as well as the analysis and interpretation of numerical results. **Teaching content :** - Fundamentals of the finite element method: notions of strong and weak formulations; Galerkin's method; finite element approximation - Application of the finite element method to non-linear problems: implementation; solving algebraic systems of non-linear equations; notion of piloting and continuation methods. - Element technology: volume and flexural locking problems; full, reduced and selective integration; beam and plate elements
UE-2 Continuum thermodynamics and behavior laws	**Number of ECTS :** 6 **Prerequisites:** Continuum Mechanics; Mechanics of Materials **Objectives:** The main objectives of this course are to present, on the one hand, a general framework for the development of behavior laws and, on the other hand, a certain number of models enabling us to approach the usual mechanical behaviors of solid materials. **Teaching content :** - Introduction: the role of behavior laws - Thermodynamics of Continuous Media (Part 1) - Thermoelasticity - Viscoelasticity - Thermodynamics of Continuous Media (Part 2) - Elastoplasticity - Elastoviscoplasticity

EU-3 Stability and non-linear mechanics	**Number of ECTS :** 6 **Prerequisites:** Mechanics and Thermodynamics of Continuous Media, Laws of Behavior (plasticity), Strength of Materials, Plate Theory **Objectives:** The aim of this course is to introduce the main concepts of the large deformation formalism and apply them to the thermodynamics of deformable media, then to address two instability phenomena: material instability through the limit analysis of elastoplastic structures (ultimate load framing with extremal principles) and geometric instability through the analysis of elastic buckling of thin or slender structures. **Teaching content :** - Large transformations: Finite transformations and strain measurements - Stresses in large strain formalism - Observational reference frames and objective derivatives - Thermodynamics of continuous media in large transformations and Fourier's law - Limit analysis: Perfectly plastic rigid behavior - Principle of Maximum Plastic Work - Variational static and kinematic approaches - Compound bending - Porticos and continuous beams in simple bending - Plates in bending - Stability of elastic structures: Introduction to buckling (geometric instability), notions of stability and bifurcation, application to discrete and continuous systems - Analytical and finite-element solution of a linearized buckling problem - Buckling of beams and plates
EU- 4 Elastomers and Composites	**Number of ECTS :** 6 **Prerequisites:** Mechanics of Continuous Media, Mechanics of Solid Polymer Materials, Finite Elements **Objective:** The aim of this course is to present the building blocks for understanding the process/material/structure triptych, using an approach based on experimental observations, modeling and numerical simulation. Students should be able to carry out a relevant numerical simulation, apply one or more dimensioning criteria and critically assess the results. Two main families of materials will be studied: composite materials (short and long fibers) and elastomers. **Teaching content :** - Rheology and processing (practical and numerical) - Isotropic (hyperelasticity theory) and anisotropic (composites) behavior laws - Thermomechanical aspects (coupling and dissipation) - Damage - Structural calculations - Sizing criteria

EU-5 Fatigue and experimental techniques	**Number of ECTS :** 6 **Prerequisites:** Continuum Mechanics; Mechanics of Materials **Objectives :** The main objectives of this course are to present the different approaches used to dimension structures for polycyclic fatigue, and to introduce a number of experimental techniques for studying the behavior of materials and structures. **Teaching content :** <u>High Cycle Fatigue</u> - Introduction - Study of the qualitative fatigue behavior of metallic materials Qualitative identification using simple tests (tensile, flexural), torsion) Qualitative identification using multiaxial tests - Model and simplified approach for fatigue design polycyclic Historical approach Transition to multiaxial loading Illustration on a structure - Multi-scale approach to fatigue design polycyclic Introducing the framework for two-scale approaches The case of the Dang Van criterion Proposed probabilistic approach Latest identification method: self-heating tests Perspectives; taking into account the influence of formatting <u>Experimental techniques</u> - In-situ displacement field measurements using stereo correlation - In situ thermal field measurements using infrared cameras - Stress analysis using the diffraction method X-rays - Operating principle of a Scanning Electron Microscope (SEM)
EU- 6 Technical scale transition	**Number of ECTS :** 6 **Prerequisites:** Continuum Mechanics; Mechanics of Materials **Objectives:** The aim of this module is to introduce the modeling of material behavior using scale transition techniques. These techniques will be used in three areas of behavior: linear elasticity, plasticity and phase transformation. **Teaching content :** - Modeling elastic behavior: general information on homogenization models, models derived from the Eshelby problem in elasticity - Elasto-plasticity modeling: generalities on plasticity, local-scale modeling, homogenization (Taylor-Lin) - Phase transformation modeling: general information on phase transformation, local-scale modeling, homogenization (Sachs, Self-coherent)

Last updated on April 11, 2025