



**IMT Nord Europe**  
École Mines-Télécom  
IMT-Université de Lille

## **Academic exchange programmes**

- totally taught in English -

Fall semester only (September 2024)

### **4 possibilities :**

- Composite materials engineering
- Materials and structure design in civil engineering
- Production management and automation
- Energy and environmental process engineering

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# Composite Materials Engineering

## General Objectives

Innovative products developed by the industry to reduce their environmental footprints by reducing their weight turn towards organic matrix composites, including the so-called materials in 'carbon'. Composites materials require dedicated designing approaches that this proposed module proposes to address.

For each stage of the product life cycle, engineers must have the necessary transversal skills to guide design projects or to lead a designing team, while ensuring their processability. Four modules are proposed here to understand the materials structures, components and manufacturing processes, to characterize their physical and mechanical properties, to master the calculation tools so as to be able to choose the proper composites and design the structures best fitting a book of requirements. At the end of the module, you will be able to lead or contribute to a design or innovative project on composite materials, interact with the contributors along the whole value chain.

## Program Description

### **Period 1 (7 ECTS) : Introduction to Composite materials and processes**

*From 09/09/2024 to 04/10/2024*

#### Objectives :

The first period focuses on the study of polymers and composite materials, their components, characteristics, markets and their position with respect to other materials. Polymers and composites processes are described and detailed according to their field of application, costs and cycle times, the materials used and the types of parts produced in terms of size, shapes and expected performances. The process control parameters as well as the possible defects generated during manufacturing are studied, through lectures but also via practical work carried out on industrial scale production units available on the IMT Research Center technological platforms.

**Skills :** The objective for the students is to be able to justify which materials can be selected according to a foreseen application, and to select an adapted process.

#### Lectures :

- Polymers and polymeric structures
- Composite materials
- Sandwich structures
- Polymer processing
- Rheology
- Composite manufacturing processes

## **Period 2 (7 ECTS) : Numerical Design**

*From 07/10/2024 to 08/11/2024*

**Objectives :** In this module the knowledge required to conduct structure dimensioning for different markets (ground transportation, aerospace, civil engineering, sport and leisure industries) is presented, including elasticity principles and numerical methods (finite element analysis).

Direct application will be conducted through a project using a commercial FEA code.

**Skills :** at the end of this module, you will be able to use mechanical and material behavior laws and apply FEA modeling for designing purposes.

**Lectures :**

- Elasticity
- Finite element Analysis
- Autonomous and group project

## **Period 3 (7 ECTS) : Innovative project**

*From 18/11/2024 to 13/12/2024*

**Objectives :** According to a precise scope given by the teaching team, find an innovative idea, and give it birth using functional analysis, CAD tools for design and first dimensioning. You will have access to the composite manufacturing lab and advanced 3D printing units to propose a prototype version of your work. Working alone, in pairs or in groups, a tutor will assist you all along the project.

**Skills :** this project will develop your personal skills, taking part into a project, standing to your opinions and work in groups. You will also have to take into account the different aspects of an innovative project, such as the market study, the functional analysis and the economical evaluation of the solution.

## **Period 4 (7 ECTS) : Composite structures Design**

*From 16/12/2024 to 24/01/2025*

**Objectives :** The aim of this module is to give the dedicated tools and methodology to well design and dimension composite parts while respecting a precise book of requirements. The laminate plate theory and failure criteria specific to structural composites are presented. Lectures on destructive and non-destructive tests methods to evaluate the material behavior and the performances of a final part complete the module. Application is conducted with an autonomous project on a given use-case.

**Skills :** you will be able to apprehend a composite design problematic including the composites specificities, and to understand the composite behavior for conducting characteristics evaluation or expertise at the end of life of a part.

**Lectures :**

- Composite destructive and non destructive characterization methods
- Thin structures modeling
- Finite element methods for laminated structures
- Project on a use case.

During the whole semester, students follow a weekly 2-hour **French course** (specific for international students), corresponding to **2 ECTS**.

*Evaluations are conducted at the end of each period with dedicated exams or project defense or report.*

# Materials and Structure Design in Civil Engineering

## General Objectives

The courses aim to upskill in the field of properties of construction materials as concrete, (fresh and hardened state), the main formulation parameters, the rheology of binders for construction, and standard tools (EN206), microstructure of the materials.

Then the lectures that teach the designing of concrete structures, metal frames constructions wherein design calculation methods and sizing will be studied will take place. The general principles of EC7 for the design of foundations and soils study with practical examples will be taught. The course on the Smart home, BIM, and new construction techniques will focus on tools to design and develop projects using the latest techniques based on data for construction, new construction methods, and techniques. To prepare engineering students to join companies later, factory visits and construction sites visits are organized.

The courses also make it possible to integrate an initiation into research with a research project that will be conducted on an identified research subject and under the supervision of one or more teacher-researchers. The project will be based on numerical and/or experimental methods. This exercise will stand for the students as a first experience in the field of research and will be the opportunity to interact with research teams.

The proposed course aims to consolidate skills in the field of construction materials and design.

At the end of the course, students can:

- Study materials and prepare formulations
- Use concrete formulation and optimization methods
- Calculate and design simple reinforced concrete or metal structures
- Use Eurocodes 0, 1, 2 and 3
- Design and modeling of structures using the power of BIM
- Perform experimental tests and characterization on construction materials
- Use civil engineering design software
- Understand a scientific and research approach
- Conduct the identification of physicochemical, mineralogical, mechanical properties, etc.

## Program Description

### **Period 1 (7 ECTS) : Materials**

*From 09/09/2024 to 04/10/2024*

Binders, Concretes, and admixtures + Rheology of building materials

Introduction of material science and engineering

Minerals

Soil physics, Rheology, and Geotechnical design

**Period 2 (7 ECTS) : Design and calculation of civil structures**

*From 07/10/2024 to 08/11/2024*

Metal frame design

Reinforced concrete design basics

**Period 3 (7 ECTS) : Structure modeling and research initiation**

*From 18/11/2024 to 13/12/2024*

Smart home and BIM

Research initiation project 1

Visits 1

**Period 4 (7 ECTS) : Construction technology**

*From 16/12/2024 to 24/01/2025*

New materials and technologies for construction

Research initiation Project 2

Visits 2

During the whole semester, students follow a weekly 2-hour **French course** (specific for international students), corresponding to **2 ECTS**.

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# Production Management and Automation

## General Objectives

Industrial processes are getting more and more complex. Managing such systems as efficiently as possible requires a rational organization of the production means and a large use of automated devices: production machines, AGV for the plants internal logistics, Programmable Logic Controller, Supervision Systems, *etc.* In this context, the automation engineer needs to be aware of the constraints that apply to a manufacturing system, as well as he has to be familiar enough with the world of production to be able to provide the sets of solutions that really fit the problems. On the other hand, he needs to master “state of the art” systems control approaches that make the manufacturing systems more competitive.

The objective of this program is to provide a solid background in terms of production management and systems control. After the successful completion of this track, the students should be able to clearly understand the objectives of an industrial automatization project, as well as the constraints that the solutions must meet. The courses provide a large set of tools from which they can pick up methods that fit the problem an effective way. Numerous lab exercises are proposed so that the students can get practical skills regarding their ability to effectively deploy the designed solutions, whatever it deals with process automation or process management.

## Program Description

### **Period 1 (7 ECTS) : Production Management**

*From 09/09/2024 to 04/10/2024*

Computer Integrated Manufacturing, Lean Manufacturing, Lean Management, Extended Enterprise, Logistics, Production Management, Scheduling, BASICS.

### **Period 2 (7 ECTS) : Industrial Process Automation (SAI)**

*From 07/10/2024 to 08/11/2024*

Linear systems, systems control, continuous time domain, discrete time domain, regulator, control law, PID controller, LQ controller, LQR controller, pole placement, time response analysis, state model, discrete events systems, programmable logic controller.

### **Period 3 (7 ECTS) : Model Predictive Control (MPC)**

*From 18/11/2024 to 13/12/2024*

predictive control, linear systems, mathematical models of dynamic plants, advanced control approach, design and implementation of MPC

**Period 4 (7 ECTS) : Software and Architecture for Mobile Robotics**

*From 16/12/2024 to 24/01/2025*

Self Localization And Mapping (SLAM), perception, computer vision, sensors, robots control, data-fusion, modular architecture, knowledge building, embedded systems.

During the whole semester, students follow a weekly 2-hour **French course** (specific for international students), corresponding to **2 ECTS**.

*Evaluations are conducted at the end of each period with dedicated exams or project defense or report.*



# Energy and Environmental Process Engineering

## Program Description

### **Period 1 (7 ECTS) : Fundamentals of environment process engineering**

*From 09/09/2024 to 04/10/2024*

These courses aim at providing to students the fundamental knowledge about sciences and technologies related to process engineering for environment. They connect fundamentals of physical chemistry with current issues of environmental engineering. Courses bring a comprehensive understanding of physical and chemical mechanisms, such as kinetics, thermodynamics, involved in catalytic, combustion or separation processes. Therefore, skills acquired are:

- Basics for process design and optimization related to in eco-friendly systems and components,
- Optimization of processes and systems for environmental issues (air, water, etc),
- Identification of relevant physical or chemical processes for pollution treatment,
- Design of separation equipment for gas-liquid absorption.
- For an effective learning, courses combine lectures, tutorials, study cases and projects for groups of students.

### **Period 2 (7 ECTS) : Fundamentals of fluid dynamics and heat transfer**

*From 07/10/2024 to 08/11/2024*

These courses aim to provide the fundamentals of fluid dynamics and heat transfer. These theoretical backgrounds are those needed to handle more complex physical phenomena or systems that are found in real applications involving flows and heat transfer: renewable energy, HVAC, energy management, pollution, process engineering, etc...

Skills acquired:

- Identify, understand and solve different types of problems involving heat transfer (conductive, convective, radiative, coupled, unsteady...).
- Solve basic problems in internal and external flows. Understand the different categories of fluids and flows (multiphasic, turbulent, non-Newtonian ...) and solve them using different approaches.
- Understand the diversity of complex and coupled physical phenomena through typical applications and adapted exercises.

### **Period 3 (7 ECTS) : Flow numerical simulation**

*From 18/11/2024 to 13/12/2024*

The goal of these courses is to provide students with the basics of numerical methods and softwares enabling the resolution of problems involving flows and/or heat and mass transfer. Various real applications are dealt with in 'project mode': industrial processes, energy engineering, natural flows and pollutant transport...

Skills acquired:

- Master the basics of the finite volume method.
- Understand the concepts involved in Computational Fluid Dynamics (CFD): mesh, boundary conditions, physical models, convergence ...
- Implement a methodology for the realization of numerical simulations using commercial software tools.
- Analyze of fluid mechanics, thermal, mixing, pollution problems ...
- Introduction to hazard calculation, industrial accidents
- Understand the importance of critical analysis of results and validation of calculations.

#### **Period 4 (7 ECTS) : Project**

*From 16/12/2024 to 24/01/2025*

The project mode allows students to experience project management and teamwork, under the supervision of an expert in the field considered.

Skills acquired:

- Carry out research and / or technical work in the field of Energy and Environment
- Make a bibliographical summary related to the subject dealt with
- Set up a study methodology to respond to the issues raised
- Analyze results and draw conclusions
- Write a summary report of the study.

During the whole semester, students follow a weekly 2-hour **French course** (specific for international students), corresponding to **2 ECTS**.

*Evaluations are conducted at the end of each period with dedicated exams or project defense or report.*