

MATERIALS SCIENCE AND ENGINEERING

MASTER OF SCIENCE

OBJECTIVES - ENVIRONMENT

Metals and alloys will play an essential role in the ecological transition of the next thirty years. In the fields of transport and energy, metals are everywhere — in nuclear and renewable energy, the electrical grid, electric vehicles, and the hydrogen economy, among others. Society needs engineers and researchers to optimise — and even invent — the processes and materials of tomorrow, which must be efficient, economical, and sustainable.

By enrolling in the MSE Master's programme, you will develop an in-depth understanding of the relationship between processing, microstructure, and mechanical properties — the core of the programme's teaching. You will learn to master the main experimental and modelling methods used in materials science. You will also receive a broad scientific education, with particular emphasis on the major ecological and societal challenges of the coming decades.

Materials Science is one of the major disciplines taught at the École des Mines de Saint-Étienne. The *Sciences des Matériaux et des Structures* (SMS) Centre, part of the Georges Friedel Laboratory, conducts world-class research on materials in collaboration with leading French and European industrial companies.

PROGRAM

24 months: full-time course program taught entirely in English and completed by validation of a Master's thesis.

COMPETENCES ACQUIRED

The MSE Master's degree will prepare you to join the research and development departments of major industrial companies as a materials or metallurgy expert, or to continue your studies by pursuing a doctoral thesis.

The programme will equip you with the following skills:

- > Excellent command of materials science and metallurgy
- > Master the relationship between processing, microstructure and mechanical properties
- > Critically discuss materials or processes for given applications
- > Break down complex problems into basic components
- > Problem solving in materials science
- > Analysis of scientific literature
- > Apply and develop characterization methods
- > Modelling and simulation in materials science
- > Take into account ethical and ecological challenges

STRONG POINTS OF THE PROGRAM

- > The MSE Master's programme places great emphasis on (inter)active teaching. If you are prepared to work hard in the classroom or in the laboratory, you will appreciate the spirit of mentoring and companionship by the teaching team!
- > Numerous collaborations with industrial partners such as Framatome, EDF, ArcelorMittal, Safran, Alfa Laval, NaTran, Aubert&Duval, etc.
- > Research facilities of international standing and variety of

subjects covered: additive manufacturing, alloy design, shaping, micro-mechanics, durability, hydrogen, etc.

- > The development, particularly in France, of the nuclear industry, renewable energies and the hydrogen economy, as well as the electrification of industry and society, in a context of increasing scarcity of mineral resources, will require a considerable research effort on materials, particularly metals. Do you want to take part in this effort?

ADMISSION REQUIREMENTS

Bachelor's (or equivalent undergraduate) Degree in Physics, Chemistry or Materials / Mechanics.

English test requirements: a B2 level is required

- > TOEIC 785
- > TOEFL 78

APPLYING

Online, full application file—go to the website

<https://www.mines-stetienne.fr/en/academic/msc-materials-science-engineering-mse/>

This program is accredited and registered as a DNM (Diplôme National de Master) as "Master Chimie et Sciences des Matériaux". RNCP (National Register for Professional Certification) n°38704.

It means it is officially recognised in France and in the whole EU, without needing to apply for an equivalence certificate.

DIVERSITY IS A KEY TO THE PROGRAM

Over thirty nationalities are represented on campus.

A small entering class allows students to study closely with faculty (faculty – student ratio is 1:10).

Students obtain paid internships.

PARTNERS

Framatome, EDF, ArcelorMittal, Safran, Aubert&Duval, Alfa Laval, NaTran, CNRS, CEA, CETIM

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COURSE AIMS

FIRST YEAR

1st semester:

- > **Materials Science:** Thermodynamics and Kinetics, Phase Diagrams, Basics of Crystal Structure, Structural Metallurgy, Selection of Materials
- > **Materials Mechanics:** Continuum Mechanics, Stress and Strain, Linear Elasticity, Beam Theory, Yield criteria, Experimental Mechanical Characterization
- > **Computing / Modelling:** Vectors, Matrices and Tensors, Ordinary Differential Equations, Statistic and Probabilities, Non-Linear Problems and Solvers, Differential Operators and Partial Differential Equations, Signal Processing and Fast Fourier Transform
- > **Ecosystems and materials:** Energy and Ecological Transition, Materials in Society, Mineral Resources, Life Cycle Analysis, Re-using, Recycling
- > **French as a Foreign Language**

2nd semester:

- > **Materials Science:** Phase Transformations, Crystal Defects, Grain Boundaries, Physics of Plastic Deformation, Solid State Diffusion
- > **Materials Mechanics:** Mechanical Failure, Continuum Damage Mechanics, Fracture Mechanics, Fatigue, Creep, Bearing Failure
- > **Materials Characterization:** Diffraction Methods for Crystallography, Optical and Electron Microscopy, Spectroscopies
- > **Computing / Modelling:** Multiscale Modelling, Molecular Dynamics for Nanomaterials, Python programming, Scale Transition with Finite Element Method
- > **Scientific Literature:** Searching, Analysing and Summarising Scientific Literature, Scientific Writing

A summer internship is possible at the end of the first year, although not mandatory.

SECOND YEAR

3rd semester :

- > **Lab project:** You are conducting a project under the supervision of a professional researcher, and you have access to the SMS centre's research equipment over the entire semester
- > **Materials Science:** Electrochemical Corrosion, Environmental Sensitive Fracture, Oxidation
- > **Materials Processes:** Plastic Forming, Thermomechanical Treatments, Additive Manufacturing
- > **Materials Characterization:** Transmission Electron Microscopy, Surface Analysis using X-ray Photo-electron Spectroscopy, Atomic Force Microscopy
- > **Computing:** Time-dependant and Non-linear Finite Element Modelling

4th semester : Master's thesis

- > **5 to 6 month internship** dedicated to a research topic in materials science, preparation of the master's thesis

LODGING

The Maison des Élèves is located 10 minutes from the Ecole des Mines and provides students with furnished accommodation in halls of residence. There are 193 rooms and 177 studio apartments, all eligible for APL housing benefit. Contact the Maison des Élèves to apply.

<https://www.me-mines-saint-etienne.org>

Services included:

- > Continuous administrative and technical assistance
- > Staff on site 24/7
- > Shared kitchens
- > Laundry room
- > Parking and bicycle shed
- > Mails and parcels

LANGUAGE OF TEACHING

English

COST

- > €6,500

CALENDAR

Three semesters of classes and a one-semester student internship. The program always starts on fall semester.

CONTACT

Program Director: Frédéric CHRISTIEN (Prof.)
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