

Short Syllabus

MECHANICAL ENGINEERING

LORRAINE
INP Ensem

ÉCOLE D'INGÉNIEURS CRÉE EN 1900

Fall Semester



PROGRAM DESCRIPTION

ENSEM – S9 COURSE CATALOGUE-COURSES AVAILABLE IN ENGLISH

Fall Semester | Master Level / Second Cycle

Engineering Specialisations

This catalogue presents the courses taught in English available to international exchange students at S9 (Master level / second cycle) at ENSEM, Université de Lorraine.

Advanced Fluid Mechanics

Course name	Lectures	Lab work	ECTS	Hours	Course reference
MULTIPHASE FLOWS AND INTERFACES	14	6	2	20	

Course Description

This course focuses on fluid–fluid interfaces, while also considering fluid–solid interfaces. It introduces the concept of interfacial tension, from its microscopic origin to its macroscopic interpretation, with applications including wetting and droplet shape.

The course then introduces multiphase-flow modelling by extending integral balance concepts to multi-phase systems and deriving interface jump conditions relevant to phase-change modelling.

Main Topics

- Interfacial and surface tension
- Theoretical modelling of multiphase flows
- Numerical modelling of multiphase flows
- CFD calculations using Fluent

Learning Outcomes

Students will be able to:

- explain the physical phenomena associated with fluid interfaces;
- understand surface and interfacial tension;
- model multiphase flows using theoretical and numerical approaches;
- apply CFD tools to engineering problems.

Prerequisites

- Fluid mechanics at first-year engineering level
- Finite-volume methods

Assessment

Engineering study involving analytical and numerical calculations using Fluent, including the study of Kelvin–Helmholtz instability.

Advanced Fluid Mechanics

Course name	Lectures	Lab work	ECTS	Hours	Course reference
TURBULENCE MODELING	10	5	2	15	

Course Description

The course introduces the fundamental concepts of turbulence and the main approaches used to model turbulent flows in engineering applications.

Main Topics

- RANS turbulence models: k - ϵ and k - ω
- LES and DNS
- Comparison and limitations of turbulence models
- Turbulent dispersion of pollutants, heat and chemical species
- CFD simulation tools and meshing
- Implementation and interpretation of turbulence models
- Applied CFD project

Learning Outcomes

- Students will be able to:
- explain the main characteristics of turbulent flows;
- select an appropriate turbulence model for a given application;
- use CFD tools to simulate turbulent flows;
- critically analyse and interpret simulation results.

Prerequisites

- Applied Mechanics (S6)
- Fluid Mechanics for Engineers (S8)
- Numerical Modeling and Simulation in Thermal, Fluid and Solid Mechanics (S8)

Assessment

Project report based on a practical CFD study carried out using Fluent.

Heat and Mass Transfer

Course name	Lectures	Lab work	ECTS	Hours	Course reference
HEAT EXCHANGERS AND WASTE-HEAT RECOVERY	20	0	2	20	

Course Description

This course covers the design and sizing of heat exchangers and introduces the main technologies used for industrial waste-heat recovery.

Main Topics

- Co-current and counter-current heat exchangers
- NTU and LMTD methods
- Heat-exchanger correlations
- Alternative heat-exchanger configurations
- Evaporators and condensers
- Waste-heat sources and exergy
- Waste-heat recovery technologies
- Applications at different temperature levels
- Nuclear cogeneration case study

Learning Outcomes

Students will be able to:

- size a heat exchanger using appropriate methods;
- analyse heat exchangers involving phase change;
- identify potential waste-heat sources;
- identify and compare waste-heat recovery technologies.

Prerequisites

Fundamentals of fluid mechanics, heat transfer and thermodynamics.

Assessment

Final examination and engineering-study report for the heat-exchanger component; project report for the waste-heat-recovery component.

Heat and Mass Transfer

Course name	Lectures	Lab work	ECTS	Hours	Course reference
FLOWS IN COMPLEX MEDIA	20	0	2	20	

Course Description

This course introduces the physical mechanisms governing fluid flow and heat and mass transfer in porous and other complex media.

Main Topics

- Porous media: porosity, tortuosity and specific surface area
- Capillary effects
- Laplace pressure
- Jurin's law
- Kelvin's law
- Sorption isotherms
- Darcy's law and permeability
- Hydrodynamic dispersion
- Coupled heat and mass transfer
- Experimental characterisation
- Industrial applications

Learning Outcomes

Students will be able to:

- describe the main characteristics of porous media;
- model flow through porous media;
- analyse experimental results;
- propose appropriate characterisation methods.

Prerequisites

Fluid mechanics and heat transfer (S7–S8).

Assessment

Written examination.

Simulation, Measurement and Mechanical Characterization

Course name	Lectures	Lab work	ECTS	Hours	Course reference
EXPERIMENTAL CHARACTERIZATION	0	20	2	20	

Course Description

This course provides hands-on experience with advanced experimental and measurement techniques used in fluid mechanics and heat transfer.

Main Topics

- Students work in groups through five practical sessions covering:
- Nuclear Magnetic Resonance (NMR)
- Laser Doppler Velocimetry (LDV)
- Particle Image Velocimetry (PIV)
- Laser-Induced Fluorescence (LIF)
- Atomic Force Microscopy (AFM)
- Scanning Thermal Microscopy (SThM)
- Infrared thermography

Learning Outcomes

Students will be able to:

- select and apply advanced experimental techniques;
- perform measurements using modern experimental equipment;
- analyse experimental data;
- apply experimental methods to fluid mechanics and heat-transfer problems.

Prerequisites

- Fluid mechanics
- Heat transfer
- Methodology for Characterisation

Assessment

Oral presentation(s) based on the practical work.

Simulation, Measurement and Mechanical Characterization

Course name

Lectures

Lab
work

ECTS

Hours

Course
reference

METHODOLOGY FOR CHARACTERIZATION

20

0

2

20

Course Description

This course introduces advanced scientific measurement techniques used in fluid mechanics and heat and mass transfer.

Main Topics

- Thermal and fluid metrology
- Laser optical diagnostics
- Particle Image Velocimetry (PIV)
- Laser-Induced Fluorescence (LIF)
- Nuclear Magnetic Resonance (NMR)
- Infrared thermography
- Atomic Force Microscopy (AFM)
- Scanning Thermal Microscopy (SThM)

Learning Outcomes

Students will be able to:

- understand the principles of advanced measurement techniques;
- design an appropriate experimental approach;
- select suitable measurement tools and methods;
- analyse and critically evaluate experimental results.

Prerequisites

- Thermodynamics
- Fluid Mechanics and Applications
- Introduction to Heat Transfer
- Fluid Energy Transfer and Conversion

Assessment

Assessment details to be confirmed according to the course format.

Mechanical Behavior of Materials

Course name	Lectures	Lab work	ECTS	Hours	Course reference
MECHANICAL BEHAVIOR OF MATERIALS	14	20	3.5	40	

Course Description

This course examines the fundamental mechanical behaviour of engineering materials and provides tools for analysing, designing and predicting the behaviour and lifetime of components and structures. **(+ 6 hours tutorials)**

Main Topics

- Isotropic elastic behaviour
- Hyperelastic behaviour
- Plasticity
- Viscoelasticity
- Stress concentrations and service life
- Anisotropic elasticity
- Composite materials
- Manufacturing and mechanical behaviour of composites
- Component and structural sizing
- Lifetime calculations
- Experimental and numerical analysis

Learning Outcomes

Students will be able to:

- characterise the mechanical behaviour of materials;
- distinguish and classify different material behaviours;
- predict and simulate material behaviour;
- estimate component and structural lifetime;
- understand the specific characteristics of composite materials.

Prerequisites

Fundamental knowledge of continuum mechanics and applied mechanics.

Assessment

Written assessment and practical-work reports.

Academic / Industrial R&D Project

Course name

Lectures

Lab work

ECTS

Hours

Course reference

ACADEMIC / INDUSTRIAL R&D PROJECT

		10	120	
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Course Description

This project enables students to apply the knowledge and skills acquired during their engineering studies to a concrete research or industrial development problem.

Projects may be carried out individually or in groups and may be proposed by an academic or industrial partner.

Main Project Stages

- Definition of project objectives
- Requirements and expected outcomes
- Functional and technical specifications
- Design and simulation
- Development
- Validation
- Analysis and reporting

Learning Outcomes

Students will gain experience in carrying out a substantial engineering project and in applying their technical knowledge to an open-ended problem.

Assessment

- Project report
- Oral defence

International Communication

Course name	Lectures	Lab work	ECTS	Hours	Course reference
PROFESSIONAL AND SCIENTIFIC COMMUNICATION	24	0	2.5	24	

Course Description

The English component is organised around two complementary areas: Professional Communication and Scientific Communication.

Professional Communication prepares students to work effectively in international professional environments, including job applications, interviews, personal branding, meetings, negotiations and project presentations.

Scientific Communication focuses on written and oral communication in scientific and technical contexts.

Main Topics

- Job applications and interviews
- CV and personal branding
- Professional communication
- International teamwork
- Meetings and negotiations
- Technical presentations
- Scientific report writing
- Abstract writing
- Technical English
- Explaining and simplifying technical concepts
- Oral scientific communication

Learning Outcomes

Students will be able to:

- communicate effectively in English in professional and scientific contexts;
- produce clear written technical and scientific documents;
- present technical information orally;
- interact effectively in international and intercultural environments.

Prerequisites

B2 level of English.

Assessment

Continuous assessment through written work, oral participation and final assessments.

International Communication

Course name	Lectures	Lab work	ECTS	Hours	Course reference
FRENCH LANGUAGE	24	0	2.5	24	

This course will introduce students to French culture and life in France through linguistic activities and exercises.

Classes will be based on various authentic documents. Through class-work students will improve their ability to build sentences in French while discovering French culture

Learning Outcomes

By the end of the course students will be able to introduce themselves, talk about interests and their environment and ask questions to others about familiar topics.

Students will be given assignments to help them review the points covered in class and prepare for upcoming classes.

Main Topics

- Socio-cultural contents (greetings, family life in France, daily routines, shopping in France, French food, work culture, etc.)
- Communication tasks (greeting people, introducing yourself, speaking about your family and habits, asking something politely, ordering food and drinks, speaking about your experience and your future plans, etc..)
- Grammar (être and avoir, articles, 1st group verbs, present, conditional in polite expressions, future, passé composé etc..)
- Vocabulary (nationalities, adjectives describing personality, family members, the house, frequency adverbs, most useful verbs, shops, food, work, jobs, studies, etc...)

Assessment

regular oral and written tests

LORRAINE INP Ensem

GRADUATE SCHOOL OF ENGINEERING SINCE 1900



École Nationale Supérieure
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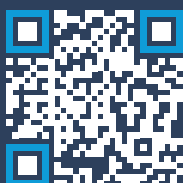
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