INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES HAUTS-DE-FRANCE

COURSE CATALOGUE 2025 - 2026

TAUGHT IN ENGLISH

ECIU university

Université Polytechnique HAUTS-DE-FRANCE

Table of contents

Please note you should choose your courses in only one speciality (MT, IAC or IE).

INTERNATIONAL MASTER
Transportation and Energy

The aim of this Master's degree is to train graduates who will be experts in the most promising new technologies in transportation and energy as well as various aspects of mechanics and energy.

Graduates will be able to:

- prepare for a career as an engineer for industrial projects and services
- acquire a valuable background in all fields of transportation on energy.

Training:

The international master "Transportation and Energy" is taught in English and offers lectures as well as individual research and development projects in the field of automotive, railway and aeronautical engineering. Students can take advantage of our experimental facilities and work directly with industrial partners (Stellantis, Alstom, Daimler, Renault, Audi, Hexa Ingenierie, Simtech, Onera, Altran, Siemens, Railtech).

Prerequisites: bachelor for entry to master 1
master 1 for entry to master 2

SEMESTER 1 (First Year)
September - January

TOOLS AND METHODS 1
Tools for data and process modelling and database querying
Bond graph approach for mechatronics
Finite element method
Operations research

DESIGN PROCESS
Introduction to design
Automotive architecture
Design process in aeronautics

SAFETY
Road safety
Car safety
Railway safety
Aircraft safety

RELIABILITY ENGINEERING AND SYSTEM SAFETY 1
System engineering
System reliability
Human centered design for transport systems

INDUSTRIALLY BASED PROJECT
Industrially based project (3 1/2 days per week, 10 weeks)
Tools for project management

FRENCH AS FOREIGN LANGUAGE

TOTAL: 30 ECTS

SEMESTER 2 (First Year)
February - June

BUSINESS MANAGEMENT
Globalization and internationalization process
Evolution of international business theory
International business environment
Industrail analysis
International business strategies and operations
Corporate strategies in global economy
Innovation management

TOOLS AND METHODS 2
Materials in transport
Introduction to energy modelling
Fourier analysis and related signal processing tools
Statistics

PRODUCTION AND TRANSPORTATION LOGISTICS
Production systems
Functional safety management
Infrastructure in railway

COMFORT AND ERGONOMICS
Thermal comfort - Air quality
Comfort and ergonomy
Comfort in railway transportation
Comfort and ergonomics in a car

RELIABILITY ENGINEERING AND SYSTEM SAFETY 2
Safety analysis
Introduction to Intelligent Transportation Systems and Applications (Autonomous vehicles: embedded systems, radars)
Human-computer interaction in transport
Reliability in the railway
Suspension systems in automotive

FRENCH AS FOREIGN LANGUAGE
French as foreing language
Communication

TOTAL: 30 ECTS

SEMESTER 1 (Second Year)
September - January

THERMAL and HYBRID MOTORIZATION, ELECTRICAL MACHINES
Internal Combustion Engine
Hybrid powertrains, Autonomous vehicles
Electric traction
Thermal Management of Hybrid Electric Vehicles and Electric Machines

INTERNAL COMBUSTION ENGINES
Combustion
Pollutant emission
Eco-driving

THERMAL MANAGEMENT OF VEHICLES
Heat transfer in a vehicle
Fluid mechanics
Global thermal management in vehicles
Energy management of hybrid electric vehicles and batteries

ENERGY AND ENVIRONMENTAL ISSUES
Energy and environmental issues in the automotive industry
Advanced System Modeling
Energy in the world
Fuels of the future (alternative fuels for automotive and aeronautics, hydrogen, fuel cell)

AERODYNAMICS AND TURBULENCE
Aerodynamics in the automotive industry
Introduction to turbulence modelling
Physics of turbulence
Computational fluid dynamics methods for vehicle aerodynamics

TOOLS AND METHODS 3
Measurement technics in heat transfer
Experimental aerodynamics

INDUSTRIALLY BASED PROJECT
Industrially based project (3 1/2 days per week, 10 weeks)
Tools for project management

FRENCH AS FOREIGN LANGUAGE

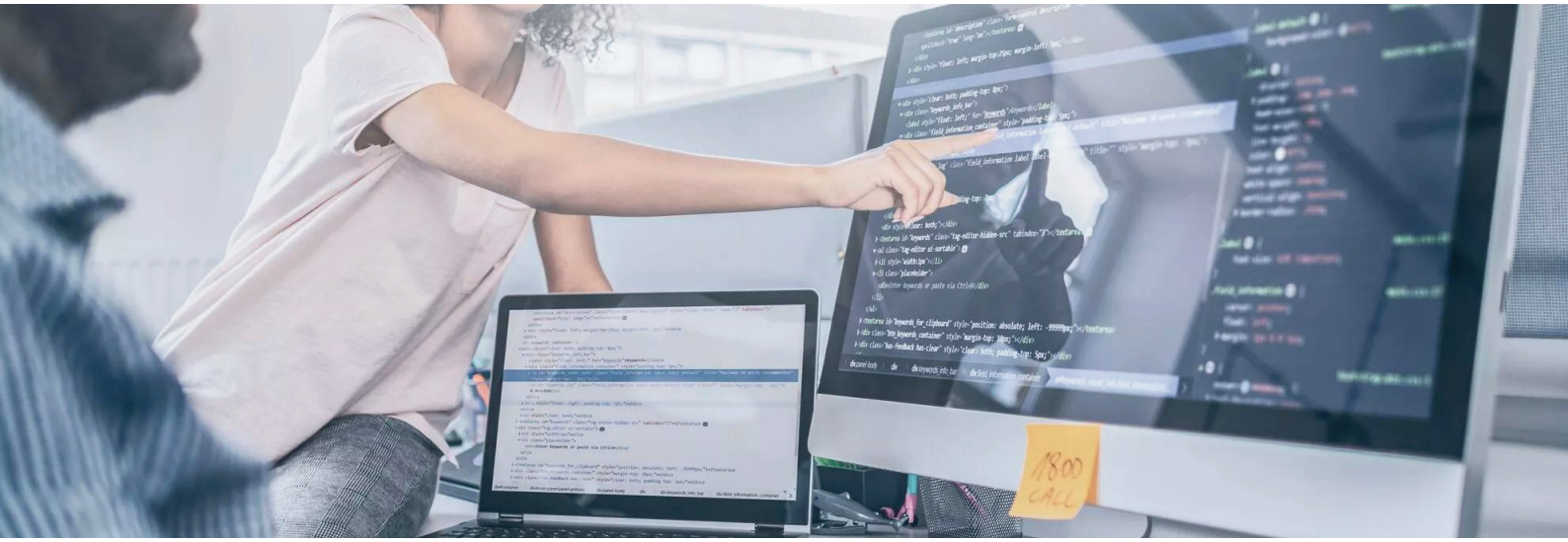
TOTAL : 30 ECTS

SEMESTER 2 (Second Year)
February - June

INTERNSHIP
In a company or a laboratory

TOTAL : 30 ECTS

International Master in Information Technology for Smart and Sustainable Mobility (IT4SSM) European alliance (EUNICE)



The Information Technology for Smart and Sustainable Mobility (IT4SSM) program is a Computer Science Master program that aims to provide knowledge and practical training in the new context of intelligent mobility while considering current issues of ethics and sustainable development. Smart mobility requires expertise in new techniques and technologies (Internet of Things, distributed date management, security of exchanges, etc.) and skills for the analysis, design and development of new algorithms and softwares for decision support in smart cities.

Key Features:

- This program offers a unique combination of European courses in the Information Technology domain for the new and promising areas of smart technologies dedicated to smart cities applications with a specific attention to the sustainability of the designed solutions.
- Courses are provided by : INSA Hauts-de-France / UPHF (France) + University of Cantabria (Spain) + Poznan University of Technology (Poland) + University of Vaasa (Finland)

Prerequisites: bachelor for entry to master 1
master 1 for entry to master 2

SEMESTER 1 (First Year)
September - January

SMART MOBILITY: ETHICS AND LEGAL ISSUES, TRANSPORT ENGINEERING AND SPATIAL DEVELOPMENT

HUMAN COMPUTER INTERACTION FOR SUSTAINABLE AND MOBILE APPLICATION

EDGE & MOBILE COMPUTING FOR SUSTAINABILITY

STOCHASTIC PROCESSES/QUEUEING SYSTEMS : MODELING AND ALGORITHMS

COMPUTER NETWORKS

MLVE : FOREIGN LANGUAGE COURSE

MP : SUSTAINABLE MOBILITY (EUNICE SHARED COURSE)

MO : OPENING COURSE

TOTAL: 30 ECTS

SEMESTER 2 (First Year)
February - June

DATA ENGINEERING FOR SUSTAINABLE AND MOBILE APPLICATION

TRAFFIC AND TRANSPORTATION MODELING

OPTIMIZATION FUNDAMENTALS

CRYPTOGRAPHY FUNDAMENTALS

NETWORK SECURITY

MLVE : FOREIGN LANGUAGE COURSE

MP : MACHINE LEARNING (EUNICE SHARED COURSE)

MO : OPENING COURSE

TOTAL: 30 ECTS

SEMESTER 1 (Second Year)
September - January

ENVIRONMENTAL, SOCIAL & ECONOMIC IMPACT OF MOBILITY SOLUTIONS

AGENT-BASED MODELING AND SIMULATION

GAME THEORY FUNDAMENTALS

INTERNET OF THINGS, SERVICES AND APPLICATIONS

SECURITY MANAGEMENT

MLVE: FOREIGN LANGUAGE COURSE

MP: STATISTICS & DATA MINING (EUNICE SHARED COURSE)

MO: OPENING COURSE

TOTAL : 30 ECTS

SEMESTER 2 (Second Year)
February - June

PROJECT

INTERNSHIP
In a company or a laboratory

TOTAL : 30 ECTS

MT: MECHATRONICS

The aim of this specialization is :

- To train high-level engineers with skills and knowledge aimed at the synergistic integration of: mechanics, electronics, automation, electrical engineering, industrial IT and modelling in order to design products with optimised functionalities.
- To allow students to join, Research & Development departments for design and to participate in the design of tomorrow's products through solid training, both theoretically and practically.

Training:

The Mechatronics specialization allows students to acquire multidisciplinary skills primarily focused on mechanics, electronics, automation and industrial IT. Its goal is to train engineers who are able to tackle a system as a whole by integrating, from the start of its design, human, financial and environmental aspects without forgetting operational safety and innovation.

SEMESTER 2
February - June

INTRODUCTION TO FINITE ELEMENTS
Fundamentals of the finite element method and formulation of basic finite elements

MICRO-CONTROLLER ENGINEERING
Computer aided electronic cards design
Programmable electronic circuits
Analog simulator study (SPICE)

AUTOMATION
Structure and synthesis of RST controllers
Sensitivity functions & pre-specification of correctors
State representation of the dynamics of a continuous or discrete system

DIGITAL SIGNAL PROCESSING
Discrete time signals and systems
Discrete fourier transform
Design methods for finite and infinite impulse response filters
Multi-cadence processing (interpolation & decimation)
Frequency analysis

ADVANCED MICRO-CONTROLLER ARCHITECTURE
Microcontroller family: PIC, AVR (Advanced Virtual RISC)
AVR microcontroller structure
Simplified calculator: Harvard architecture
Data transfer RISC instruction set: storage, subroutines, addressing modes

BUSINESS MANAGEMENT
Globalisation and internationalisation process
Evolution of international business theory
International business environment
Industrial analysis
International business strategies and operations
Corporate strategies in a global economy
Innovation management

INNOVATION AND CREATIVITY PROJECT

5-day project focused on innovation and societal aspects
Human-centred "design thinking" approach
Development of creativity in a cooperative environment in contact with users
Defense in front of a jury composed of teachers, industrial partners, …

FRENCH COURSES

Prerequisite: bachelor

TOTAL : 30 ECTS

IAC:
INDUSTRIAL AND AUTOMATIC COMPUTING

The aim of this specialization is:

To provide research and development engineers with solid theoretical and practical skills to design, analyze, develop and implement autonomous systems using control engineering and IT tools. In particular, IAC engineers will have the skills to define the overall architecture of modern automated systems and implement them by integrating elementary building blocks and ensuring their interconnections.

They will also be able to design these same elementary building blocks, developing specific control laws and taking human factors issues into account. These skills will be acquired in a variety of application areas, such as the Factory of the Future, ground transportation, industrial and service robotics, health and mobility technologies.

Training:
This training is based on general theory and specialized courses in automation and control, through traditional courses as well as numerous hands-on activities on educational platforms such as autonomous vehicles, industrial and mobile robots, engine test benches, flexible workshops, etc.

SEMESTER 1
September - January

ARTIFICIAL INTELLIGENCE FOR AUTOMATION
Introduction to artificial intelligence
Gradient-based optimisation methods
Artificial neuron model
Learning the weights of a neural network
LSTM Structure and learning of deep network weights

AUTONOMOUS VEHICLE AND SIMULATION
Human-machine interactions in autonomous vehicles
Interaction and cooperation in driving
Simulation: challenges and possibilities
Types of simulator
Analysis methods, measurements, performance or degraded situation indicators

INTEGRATIVE PROJECT AUTONOMOUS AND COOPERATIVE VEHICLES
Study of an autonomous vehicle
Application of the knowledge and management techniques of a project
Definition of the Use Cases of the concept, the information and decision-making functions
Development of the various functions and their tests on a simulator for validation and implementation on a real vehicle
Scanner simulator, AVS-Simulation

BIOMECHANIS
Elements of human mechanics (anatomy, physiology and general biomechanics)
Human biomechanics: from solid mechanics to human movement
Main sensors and measurement tools for the analysis of the human movement
Signal processing (sampling theorem, Fourier transform, frequency analysis, ...)
Practical work

CONTROL OF COMPLEX SYSTEM

Theory of the optimum command and introduction to the non-linear systems
Dynamic computing
Problem of an optimum command: choice of criteria as a function of the objective (minimum energy and time, …)
Technological limits
Application to the command of LPV systems

INTEGRATIVE PROJECT TECHNOLOGY FOR HEALTH AUTONOMY

Study of a problem involving assistance for a disabled person
Work in interaction with other disciplines (electronics, mechanics, IT)
Definition of needs, the functions to be developed and the interactions to be set up with the person, testing and validation.
Work with severely disabled people, around a robotic arm to help them.
Implement actions that involve the machine and human working together

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FRENCH COURSES

PROJECT

ELECTIVE COURSES

Prerequisite: master 1

TOTAL : 30 ECTS

SEMESTER 2
February - June

DIAGNOSTICS AND RECONFIGURATION

Introduction: background to the diagnostics (monitoring and supervision, remote operation, maintenance policy)
Formulation of a diagnostic problem (different types of anomalies: disturbances and modeling uncertainties)
Diagnostic methods and tools
Decision support

STATE SPACE AND ROBUST CONTROL

Analysis of the properties of a system modeled by state representation
Modeling of uncertainties
Notions of robust control
Practical work
Control of a powertrain

ADVANCED POWERTRAIN CONTROL

General information on automotive engines
Modeling and control of internal combustion engines
Vehicle dynamics and application to the design of electric and hybrid vehicles
Implementation of energy management strategies

INTEGRATIVE PROJECT ADVANCED POWERTRAIN MANAGEMENT

Study of powertrains with the control of energy consumption and pollutant emissions
Collaborative or competitive project
Scenarii of setpoints/disruptions and breakdowns/faults
Tests on engine benches

FUTURE FACTORY AND ROBOTICS 1

Manufacturing

MES system or integrated real-time production control
MES functions
Main indicators for monitoring and optimising the production performance, quality, product tracking, energy consumption
Hardware and software architectures
Development of a MES application (characteristics, method)
Main MES software packages and integrators on the market

FUTURE FACTORY AND ROBOTICS 2

Mobile Robotics

Design and implement the various functions (perception, trajectory planning, guidance) in mobile robotics based on specifications
Design the layout of a fleet of mobile robots for industrial or service applications
Check the optimality of the movements obtained

FUTURE INTEGRATIVE PROJECT

Work in project teams and in a quasi-industrial context
Analysis and development of the components of the control architecture for the flexible production cell at INSA Hauts-de-France
Development of distributed automation based on field networks, robot control, supervision
Development of human-machine interfaces, product traceability

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AUTONOMOUS AND COOPERATIVE VEHICLES 1

Automation and Automotive engineering
Introduction and context (road safety, vehicle of the future, etc...)
Driving assistance functions
Standardised levels of automation
Modelling of vehicle dynamics
Main driving risk indicators and their calculation
or estimation methods

ADAS AND AUTONOMOUS VEHICLES

Understand the dynamic environment around a vehicle
Mathematical models to represent the position of a vehicle in relation to a reference: environment/map
Sensors used to perceive the environment and their limitations, to automate certain driving functions
Differential GPS (DGPS) : measuring position in relation to a fixed receiver

AUTONOMOUS VEHICLES INTEGRATIVE PROJECT

Work in team on the applications of the transportation
Use of the test benches and platforms of INSA Hauts-de-France
Use of software (Matlab/Simulink, LabVIEW) for the modeling and the development of driving help

INNOVATION AND CREATIVITY PROJECT

5-day project with innovation and societal aspects Human-centred "design thinking" approach
Development of creativity in a cooperative mode in contact with users
Defense in front of a jury composed of teachers, industrial partners…

BUSINESS MANAGEMENT

Globalization and internationalization process
Evolution of international business theory
International business environment
Industrial analysis
International business strategies and operations
Corporate strategies in a global economy
Innovation management

FRENCH COURSES

Prerequisite: bachelor

TOTAL : 30 ECTS

INDUSTRIAL ENGINEERING

The Industrial Engineering specialization enables students to understand complex industrial and socio-technical systems in their entirety, to design, analyze, model, simulate, develop and optimize them. The skills and knowledge acquired apply to all the functions of the entrerpise: logistics, production, maintenance, quality, information systems management, etc. Graduates will be the company architects involved in the digital transformation projects of industry 4.0. and service systems. They will be able to integrate and use technologies in industrial systems in an ethical and regulatory manner.

SEMESTER 1
September - January

PRODUCTION SYSTEM MANAGEMENT
Enterprise resources planning
Business processes and information systems
Enterprise Resource Planning (ERP)
Customer Relationship Management (CRM)
Supply Chain Management (SCM)
Case studies
Setting up and using E-prelude

PLANNING / SCHEDULING
The new challenges of planning and scheduling in the context of the Factory of the Future
Typology of production systems
Modeling and solving planning problems
Tools and models for optimizing production systems
Real-time scheduling and simulation-optimization coupling

QUALITY MANAGEMENT
Definitions and criteria of quality management systems
Statistical approaches: data acquisition and data processing
Non-statistical approaches: group work and quality function deployment

INITIATION TO RESEARCH ON INDUSTRIAL ENGINEERING
Scientific research methodology
Presentation of industrial engineering research projects
Research project with a topic to be dealt with ...
Completion of a research project during the practical sessions

FUNCTIONS OF THE DIGITAL FACTORY

Business processes and information systems
Enterprise Resource Planning (ERP)
Manufacturing Execution System (MES)
Supervisory Control and Data Acquisition (SCADA)
Data acquisition from distributed equipment and PLCs
OPC servers, MES functions, ISA 88 and ISA 95 standards

DECISIONAL PROCESSES ENGINEERING

Part 1 : Modeling and analysis of the company's decision-making system

- Systemics and modeling
- Modeling, diagnosis and reengineering of decision-making processes
- Case studies: GRAI method

Part 2 : Business intelligence

- Business intelligence suite
- Modeling for storage architecture
- Data quality, data preparation (normalization, discretization)
- Data mining and process mining

TOOLS OF THE DIGITAL FACTORY

Smart machines
Technological building blocks for flexible cells
Intelligent and communicating products
Robot cell configuration taking agility and safety into account.

VIRTUAL COMMISSIONING

Design, analysis and sizing of production lines based on digital models.
Machine and sensor layout.
Design, simulation and signal synchronization between digital models.
Ergonomic design and validation of human tasks.
Elements of human physiology and human tasks
Digital modeling and ergonomic analysis of human tasks.

INDUSTRIALLY BASED GROUP PROJECT

ELECTIVE COURSES

FRENCH COURSES

Prerequisite: master 1

TOTAL : 30 ECTS

PROJECT IN A LABORATORY

INSA Hauts-de-France has four laboratories where students can undertake:

- Project only: 30 ECTS
- Project + courses: 30 ECTS

If students wish to take courses alongside the project, the courses must be selected from those listed above, while still choosing all courses from a single formation.

Laboratories :

Laboratory of Industrial and Human Automation and Control, Mechanical Engineering and Computer Science

Digital communications, Micro and nano systems, Ultrasonic control and characterization, Acousto-optic systems, Optronics

Ceramic materials, manufacturing and processes, physicochemical characterization, bioceramics

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