Specialisations in years 2 and 3
Engineering training with a focus on major societal challenges

MANUFACTURING
> Aeronautics
> Product Engineering
> Mechanical Engineering for Materials & Manufacturing Processes
> Robotics
> Embedded Control & Power Grids
> Industrial Engineering

DIGITAL ECONOMY
> Computer Science
> Mathematics & Applications
> Advanced Modelling & Analysis for structures
> Virtual Reality
> Data Analysis and Applications in Signal and Image Processing

GEOMATIC, CIVIL & ENVIRONMENTAL ENGINEERING
> Civil Engineering & Sustainable Construction
> Engineering Science for Housing and Urban Environment
> Digital City

ENERGY, OCEAN
> Ocean
> Energy Production and Management
> Propulsion and Transport

HEALTH
> Digital Sciences for Life Sciences and Healthcare

RESEARCH PROGRAMME
> Doctorate (open to third year students only)

PROJECT SPECIALISATIONS
> Scientific Challenge 2024
> Environment Mobility Health
> Net-zero emissions

PROFESSIONAL OPTIONS
> Healthcare Engineering (new for 2020/21)
> Personal Project
> Entrepreneurship
> Business Finance
> International Business Development
> Engineering for Ecological Transition
> Engineering and digital sciences for art, culture and heritage
> Management, Leadership, Communication
> Research and Development
> Science and Music
> Disrupt’ Campus Nantes

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GROUPE CENTRALE
Aeronautics must adapt to future requirements. On the one hand, growing demand from travelers for a fast, safe and economical means of transport, suggests that civilian air traffic will double by 2030-2040. On the other hand, growing public attention and sensitivity towards ecological and environmental problems is putting considerable pressure on the development of aeronautics.

In order to adapt, the aeronautics sector must respond accordingly to new challenges:

- on a **scientific and technical** level, reducing the “environmental footprint” of civilian aircraft
- on a **cultural** level, with the “nuclearisation” of this means of transport
- on a **human** level, with specific training needs in new techniques and applications in aeronautics

The Aeronautical Specialisation provides general knowledge in the fields of aerodynamics, aeronautical materials and structures, allowing the Centralian engineer to contribute to the far-reaching future developments in aeronautics.

**2ND AND 3RD YEAR SPECIALISATION**

**AERONAUTICS**

**COURSE CONTENT**

- Gas dynamics
- Aircraft structure modelling
- Introduction to numerical computation
- Flight dynamics
- Aircraft design and construction
- Inviscid aerodynamics
- Aircraft propulsion

- Turbulence modelling
- Computational aerodynamics
- Aeroacoustics
- Structural dynamics
- Passive safety of aerodynamic structures
- Project
EXAMPLES OF PAST R&D PROJECTS

> Numerical modelling of the reduction drag of a wing with Gurney flaps.
> Aircraft of VLA kind with hybrid engine.
> Design of a propulsive system by MHD.
> Aerodynamic design of an electric ULM.
> Control of the boundary-layer separation close to a wing.
> Flight simulation of a shaped hypersonic vehicle.
> Trajectory optimization of a drone.

EXAMPLES OF INTERNSHIPS UNDERTAKEN BY PREVIOUS STUDENTS

> Improving comfort in Falcon aircrafts. (Dassault)
> Analysis and definition of a sensor in the Soyuz world. (ArianeEspace)
> Computation of aircraft structures by using NASTRAN, (AIRBUS)
> Contribution to micro-gravity research effects (AIRBUS)
> Implementation of a Java code for nozzle modelling (SNECMA)
> Technical study of airport logistics (AIRBUS)
> Design and study of a methodology to evaluate aircrafts noise (AIRBUS)

INDUSTRY SECTORS

> Aircraft construction (Airbus, Eurocopter, BAE Systems, Stelia Aerospace, Dassault Aviation, Saab Aerospace, MBDA)
> Engine/Components manufacturers (Safran/SNECMA, Turboméca, Rolls-Royce, Techspace Aero, DAHER, GKN, Sagem)
> Research and development (ONERA, CNES, DLR, MBDA, Ariane Espace)
> Simulation (Thalès, Altran, Dassault Systems)
> Servicing/Maintenance /Logistics (Airports, Supply chains)

CAREER PROSPECTS

> Trade/finance/logistics
> Research/CFD
> Engines
> Materials/structures
> Production
> Design/flight testing

DOUBLE DEGREE PROGRAMMES WITH:

> University of Cranfield, Imperial College (GB)
> Georgia Tech, Michigan, Pennsylvania, Minnesota Universities (USA)
> KTH University (Sweden), Keio University (Japan), McGill University (Canada)
> Politecnico di Milano (Italy), Delft University of Technology (Netherlands)

TEACHING STAFF

HEAD OF SPECIALISATION:
Guy Capdeville

LECTURERS:
I. Calmet, L. Gornet, P. Rozycki, H. Oudin, L. Perret, P. Cosson, B. Conan, Ph. Blot (Industry), L. Paté (SNECMA)

CONTACT:
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Providing students with a complete picture of the design/industrialisation process of a manufactured product. They will acquire technological and scientific skills to understand the product development and industrialisation processes at all stages of the product lifecycle.

**COURSE CONTENT**

- Product design
- Materials selection and processing
- Product modelling and development
- Product use
- Objects and machines control and programming
- Production compliance and stability
- Design of experiments
- Manufacturing Processes
- Project 1
- Industrial Design
- Costing, purchasing, and pricing
- Production Management
- Rapid Manufacturing
- Project 2
EXAMPLES OF PREVIOUS PROJECTS

> Study and development of a POMER - self-sufficient energy-generating unit fed by a hydrogen fuel cell (Pure E.T.)
> Optimization of an international moth racing dinghy (Benoit Marie, Skipper)
> Development of a system to recycle components and materials - (Veolia)
> Design of a mobile system to carry out the regulatory load bearing tests of sports equipment (Sportest)
> Design and development of tools for escalator maintenance (Enerpac)
> Study and development of a recharging station for VAE in the public space (Abri Plus)

EXAMPLES OF PREVIOUS INTERNSHIPS

> Numerical modelling of foundry forming processes (Transvalor)
> Maintenance of power tools (Airbus)
> Technical and Financial Studies Manager (Naval Group)
> Lead Design Development Manager (Plastic Omnium)
> Study of a solution for industrial tools (Dessoutter tools)
> Quality Engineer (Thales)
> Structural design and manufacturing study of a float for an autonomous desalination system (Oneka technologies)
> Numerical modelling, Piloting the resolution of architecture and implementation problems (Renault)
> Predictive maintenance (Arianespace)
> Design of automotive parts (MBtech Bohemia s.r.o., Prague)
> Creation of a standard range (Safran Aircraft Engines)

TEACHING STAFF

HEAD OF SPECIALISATION:
Matthieu Rauch

LECTURERS:
Jérôme Friant, Jean-Yves Hascoët, Olivier Legoff, Catherine Michel, Gilles Carabin, Jean-François Petiot, Emilie Poiron, Matthieu Rauch, Hervé Thomas

EXTERNAL SPEAKERS:
Stelia Aérospace, Faurecia, Dessoutter, ENSAM, Audencia Business School, École de Design de Nantes Atlantique, Nantes University Hospital, L’Oréal

CONTACT:
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MECHANICAL ENGINEERING FOR MATERIALS & MANUFACTURING PROCESSES

To train general engineering students in materials mechanics with particular expertise in manufacturing and implementation processes. Apprehend a design and/or manufacturing problem in its entirety and complexity: choose the material and the process, evaluate the mechanical strength and durability, with a constant emphasis on innovation and respect for ecological principles.

COURSE CONTENT

- Materials selection in mechanical design
- Finite Element Method
- Structural mechanics
- Experimental methods in materials science
- Physical and mechanical metallurgy
- Non-linear continuum mechanics
- Polymers and composites
- Sustainable materials policy
- Conferences and company visits
- Fatigue and fracture of materials
- Project 1 and 2
- Metal forming and processing
- Polymer processing
- Composite processing
EXAMPLES OF PREVIOUS PROJECTS

> Composite processes applied to electric motors: definition and testing of capillary impregnation in fibrous media
> Determination of the characteristics of «eco-responsible» composites
> Construction of a multiaxial fatigue curve for synthetic rubber
> Optimal coupling of data-driven mechanical simulation and numerical homogenization techniques for structural calculations
> A fractal material to trap cracks?
> Additive manufacturing and composite materials: specifications and limitations
> Magnetic pulse spot welding of metal alloys

EXAMPLES OF PREVIOUS INTERNSHIPS

> Study of the natural character of flax fibre: influence of beam variability on their mechanical behaviour (Depestele, France)
> Dynamic transformation in titanium alloy Ti-10-2-3 (Ecole de Technologie Supérieure, Canada)
> Simulation of metallic additive manufacturing (Naval Group, France)
> Study of the behaviour of a seal in a fuel cell (Faurecia, France)
> Modeling the behaviour law of a polymer used for sports shoe soles (Arkema, France)
> Mechanical characterization of a composite with long staple fibres (Safran, France)
> Compensation of microstructure effect during ultrasonic residual stress measurement, Veğer (Bristol, UK)
> Reuse of waste plastic fibres from discarded fishing nets as shrinkage cracking prevention of cement-based specimen, DTU (Copenhagen, Denmark)
> Study of the weldability of a new superalloy, Aubert & Duval (Clermont-Ferrand, France) / TWI (Cambridge, UK)
The robotics specialisation trains multidisciplinary engineers (modelling, design, programming) capable of understanding robotic systems (manipulator, parallel, walking, flying, submarine, etc.) and how they work. The course is focused on innovation and high technology.

This is innovative training for the high-tech sectors of industrial robotics and/or production, transport (autonomous vehicles), and health (medical robots).

Students are trained in the design and development of complex mechanical systems. These future engineers who are oriented towards R&D and may or may not become integration engineers, can lead teams of specialists in robotics, mechatronics or real-time simulation.

Courses are strongly linked to the undertaking of projects, supported by the research teams at Centrale Nantes.

### COURSE CONTENT

- Robot modelling
- Robot design
- Advanced programming
- Vision for robotics
- Control and observation systems
- Intelligent vehicles and transport
- Aerial and submarine robots
- Middleware
- Robot control
- Planning
- Parallel and humanoid robots
- Integration (Project)
EXAMPLES OF PREVIOUS PROJECTS

- Dynamic simulation and control of submarines equipped with steerable thrusters
- Multi-robot locating system.
- "Barman" Robot: Use the Baxter robot to serve drinks, as a demo.
- Pioneer P3-AT Robot: Follow a predefined path.
- ROS: piloting laws for parrot drones

EXAMPLES OF PREVIOUS INTERNSHIPS

- Development, optimization and security of robotic applications at the Nantes plant (Airbus SAS Operations)
- Vision-guided navigation in dynamic environments (LAAS-Toulouse)
- Definition and development of a library for innovative industrial robots (Sitia)
- Strategies for moving a mobile robot in a constrained space (Stanley Robotics)
- Correlation studies between flight trajectories and sensor errors of an inertial sensor unit (French Ministry of Defence)

INDUSTRY SECTORS

- Transport (automotive, aerospace, aeronautics, shipping)
- Food processing, agriculture
- Healthcare
- Arts and culture

In addition to the sectors traditionally open to robotics engineers, this specialisation offers opportunities in the growing sectors of autonomous driving, aeronautics and medical robotics

CAREER PROSPECTS

- R&D engineer
- Production engineer
- Operations engineer

TEACHING STAFF

HEAD OF SPECIALISATION:
Abdelhamid Chriette

CENTRALE NANTES LECTURERS:
Abdelhamid Chriette, Gaëtan Garcia, Olivier Kermorgant, Guy Lebret, Vincent Frémont, Pierre Molinaro, Franck Plestan, Sophie Sakka

CNRS:
Isabelle Fantoni (CNRS)
Stéphane Caro (CNRS)
Franck Mars (CNRS)
Isabelle Milleville (CNRS)

CONTACT:
adbelhamid.chriette@ec-nantes.fr
EMBEDDED CONTROL AND POWER GRIDS

“From system specification to embedded software”
Master a range of design and implementation tools for control laws and embedded software solutions; and acquire a global perspective of the development chain for a control system.

COURSE CONTENT

- Embedded systems software
- Modelling and verification of embedded systems
- Discrete time implementation of control laws
- Systems identification and signal filtering
- Control methodology of linear systems
- Advanced control of non-linear systems
- Interconnected systems
- Real-Time Operating Kernel
- Synchronous automation and supervision
- Simulation of dynamical systems
- Analysis and control of power systems
- Advanced control of linear systems
- Projects
EXAMPLES OF PREVIOUS PROJECTS

> Analysis of the dynamics of an electrical generator coupled to a power grid (RTE Chair).
> Steering of the sails of a hybrid diesel/sailboat (linked to the contract between STX and the IRCCyN laboratory).
> Control of a pico brewery with an Arduino microcontroller and a smartphone.
> Construction of a mini Segway vehicle controlled by an Arduino microcontroller.
> Production of a ROV (Remote Operated Vehicle).
> Production of a connected greenhouse
> Control methodology for Saildrone
> Study of a WiFi module
> Managing electric vehicle charging (in collaboration with Renault).
> Aerial video tracking system (in collaboration with Thales).

EXAMPLES OF PREVIOUS INTERNSHIPS

> Study on embedded Ethernet switches on telecommunications microprocessors for avionics software (Airbus)
> Hybrid powertrain simulation (PSA)
> Development of a 2D/3D HMI plugin for Matlab/Simulink (MBDA)
> Determination of the flight altitude of an aircraft (MBDA)
> Study on electric vehicle charging (Renault Technocentre)
> Avionics Architecture Optimisation (ATR).
> Robust control law for the transmission of mobile articulated machines (Secom Engineering)
> Extension of Cyber Security surveillance probes to embedded systems (Thales Air Systems)
> Integration of renewable energies on the network with the Linky meter (EDF R&D)
Gain the capacity to understand a company and its organisation from an overall perspective (extended enterprise, information system, process, quality and standards etc), and acquire the tools and methods for optimal management (decision making, production management, supply chain, change management etc.)

**COURSE CONTENT**

- Roles and organization
- Sustainable Production
- Decision-making tools and methods
- Product modelling
- Enterprise modelling and performance
- Information systems and knowledge management
- Risk management
- Processes, quality and standards
- Value networks
- Costing, purchasing and pricing
- Change management
- Simulation and operations research
- Project
EXAMPLES OF PREVIOUS PROJECTS

> Study of the ergonomics of a workstation for Daher Socata.
> Study of a chassis identification system for Bobcat.
> Definition of a quotation support system for MTA Industrie.
> Study of the impact of AI for change management for ORESYS
> Optimization of maintenance plans for SNCF

EXAMPLES OF PREVIOUS INTERNSHIPS

> Continuous improvement
> Optimization of production
> Logistics and Supply
> Junior Management Consultant

INDUSTRY SECTORS

> All (automotive, aeronautics, defence, food processing, IT or company performance consultancy etc)

CAREER PROSPECTS

> Production management/organisation, management of industrial processes
> Internal and external supply chain
> Stocks / purchasing
> Costing / pricing
> Consultancy (information systems, continuous improvement)
> Industrial reference and best practice systems

TEACHING STAFF

HEAD OF SPECIALISATION:
Raphaël Chenouard

LECTURERS:
Catherine da Cunha, Frédéric Alexis, Thomas Lechevallier, Jean-François Petiot, Jean-Yves Hascoët, Farouk Belkadi, Matthieu Rauch, Alain Bernard, Florent Laroche, Hervé Thomas, Pascal Gilquin

CONTACT:
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2ND AND 3RD YEAR SPECIALISATION

COMPUTER SCIENCE

Providing future engineers with the knowledge required to manage IT projects across all sectors of application. The course deals with the major concepts required for the majority of projects, from the different perspectives of customer, contractor and project manager. Two options: Computer Engineering or Information Systems.

COURSE CONTENT

> Databases
> Software Engineering
> Discrete Mathematics
> Object Oriented Programming
> Industrial Software Development
> Security
> Systems and Networks
> Language Theory
> Artificial Intelligence
> Software Development Project
> Group Project

COMPUTER ENGINEERING OPTION

> Concurrency and formal methods
> Functional Programming
> Logic Programming

INFORMATION SYSTEMS OPTION

> UI-UX Design and Mobile programming
> Web programming
> Information Systems
INDUSTRY SECTORS

> IT services
> IT Consultancy
> large industrial groups
> SMEs
> Banking and insurance

CAREER PROSPECTS

> Software Analyst, Designer, Systems Integration
> Web and IT developer
> Information Systems Architect
> IT Support
> IT Project manager
> Systems and data security
> Data Scientist

TEACHING STAFF

HEAD OF SPECIALISATION:
Jean-Yves Martin

CENTRALE NANTES LECTURERS:
Carito Guziolowski, Jean-Sébastien Le-Brizaut, Didier Lime, Morgan Magnin, Jean-Yves Martin, Pierre Molinaro, Guillaume Moreau, Olivier Roux, Myriam Servières, Vincent Tourné

EXTERNAL SPEAKERS:
Pierre Auclair (RippleMotion), Raphaëlle Chapuis (EY), Victori en Foret (CGI), Félix Lecuyer (Wavestone), Éric Paille (TOTAL), Yves Schuller (Cap Gemini), Guillaume Sevestre (Voyage SNCF), Benjamin Vialle (CNIL).

EXAMPLES OF PREVIOUS PROJECTS

> Simulation of interaction between DNA strands
> Management software tool for an entomology association
> Roll-out of an automatic generator/corrector of multiple choice tests
> Construction of collaborative abstracts on Android
> Implementation of an API demonstrator for form recognition (MyScript)
> Android application for a healthcare protocol (Nantes University Hospital)
> Implementation of computerized discharge prescriptions at Nantes University Hospital

EXAMPLES OF PREVIOUS INTERNSHIPS

> Web API for cloud-based energy management and forecast (Watts Ltd)
> Big data and unstructured data (Solucom)
> Development of a customer management software tool (iOS, Android and Web) for flight cancellations (Amadeus)
> Security in IT services companies (Natixis)
> Paperless social security returns (Sopra)
> Cyber Defence consulting (Sopra)
> Natural User Interface (University of Dublin, Microsoft, Skype)
> Project portfolio management support (Total)
> Automated reporting (Crédit Agricole CIB)
> Data acquisition software (DCNS)

CONTACT:
jean-yves.martin@ec-nantes.fr
This specialisation provides a broad-based curriculum in applied mathematics, from the core notions in analysis, probability and statistics to more applied vocational concepts in statistical learning or scientific computing. The multidisciplinary nature of this specialisation represents an advantage across a wide range of sectors requiring a sound understanding of mathematical tools and concepts in order to meet new technical and economic challenges.

The aim is not only to provide a solid grounding in mathematics, but also a good grasp of the current issues in applied mathematics. The teaching staff undertake research linked to different industrial sectors, thus illustrating mathematical concepts and tools on concrete applications and guiding students towards possible career orientations.

**CORE COURSES:**
- Probability
- Hilbertian analysis
- Probabilistic numerical methods
- Statistical learning
- Advanced statistical learning
- Stochastic processes
- Uncertainty quantification
- Project

**NUMERICAL ANALYSIS AND PROBABILITY TRACK:**
- Partial differential equations
- Numerical analysis
- Advanced numerical analysis
- Stochastic modelling
- Modelling for health and biology

**STATISTICS AND DATA SCIENCE TRACK:**
- Statistics 1
- Statistics 2
- Data science with R
- Foundations of statistical learning
- Bayesian methods and hierarchical models
EXAMPLES OF PREVIOUS PROJECTS

- Portfolio optimization
- Monte Carlo methods for rare event estimation
- Patterns of Alan Turing
- Portfolio risk measures
- Population dynamics and breast cancer tumor growth modelling
- Data mining for the analysis of petroglyphs
- Numerical simulation of the transport of nuclear waste
- Matrix completion for painting restoration
- Multilevel Monte Carlo methods for option pricing
- Study of the graph of Erdos Renyi
- Numerical simulation of neural influx in neurons
- Approximation power of deep neural networks
- Introduction to quantum computing

EXAMPLES OF PREVIOUS INTERNSHIPS

- Classification and Forecasting of load curves (GDF Suez strategy division)
- Outsourcing of post-trade tasks (Accenture)
- Integration of external variables to optimize hotel prices (Amadeus)
- Development of a simulator (Thalès Alenia Space)
- Reporting of investment funds (Prévoir)
- Environmental characterization of the aircraft fleet (Safran)
- Actuarial problems in reinsurance (Wills Re)
- Reliability assessment of hybrid dynamical systems (EDF, Division Management of Industrial Risks)
- Reporting of market risks for gas portfolio (EDF, Division Economy, Rate and Price)
- Combination of statistical models for photovoltaic power forecasting (Reuniwatt)
- Optimization of a statistical tool for sale forecasting (PSA)
- Stochastic methods for the solution of high-dimensional PDEs (Ecole Centrale Nantes)
- Passenger traffic forecasting models for decision suppr (SNCF)
- Machine Learning applied to market abuse (HSBC)
- NLP for automatic processing of legal documents (Stackadoc)
- Optimization for precision viticulture (INRA)
- Prediction of annuity revaluation costs (Generali)
- Peptide retention time prediction (Functional Genomics Center Zurich)

CENTRALE NANTES

An engineering school and member of the Centrale Group. Its graduate, master and PhD programmes are based on the latest scientific and technological developments and the best management practices. Founded in 1919, Centrale Nantes’ 40-acre campus welcomes 2,320 students, including 1,950 graduate students, 150 Executive Education and degree apprenticeship students, 240 PhD students and 380 Master and Advanced Master students.
To train engineers with strong skills in both modelling and numerical simulation in mechanics, and with an opening towards new experimental field measurement techniques. This analytical approach combining simulation and image-based experimental methods for solid mechanics is likely to play a major role in the solutions that science and technology can provide to the challenges of tomorrow (factory of the future, sustainable development, health, energy and mobility). More than preparing the student for a specific profession, the purpose of this specialisation is to instruct the engineer in this dual approach to analysis, which can then be applied to numerous industrial fields (automotive, aeronautics, space, energy, railway, naval, environment).

COURSE CONTENT

- Composite structures
- Finite element method
- Structural mechanics
- Solid dynamics and modal analysis
- Plasticity of structures
- Finite element modelling and methodology
- Numerical methods for non-linear mechanics
- Fracture and damage mechanics
- Project (Part 1)
- Crashworthiness and transportation safety
- Numerical methods for experimental analysis
- Multiphysic couplings
- Scientific conferences
- Project (Part 2)
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EXAMPLES OF PREVIOUS PROJECTS
> Modelling of a fluid flow around a flexible structure
> Design and simulation of a crash system
> Simulation of magnetic pulse crimping
> Simulation composite material ruin
> Calculation from 2D / 3D images.
> Modelling of electric cables for floating wind turbines.
> Welding modelling.
> Simulation of acoustic environments.
> Study of large excavation stability

EXAMPLES OF PREVIOUS INTERNISHIPS
> Simulation of blade loss in a reactor (Snecma)
> Identification of acoustic leakage (Renault)
> Mechanical modelling of fuel assemblies (Areva)
> Dynamics of space launchers (EADS)
> Deployment of space structures (Thalès)
> Simulation in watch-making (Swatch)
> Simulation of the individual movements of a foetus
> Simulation of moving structures (Michelin)
> Reliability and sizing optimisation of a hydro-turbine (HydrOcean).

INDUSTRY SECTORS
> Transport (rail, automotive, aeronautics, space, naval)
> Energies (nuclear, fossil fuels, renewables)
> R&D
> Biomedical sector

CAREER PROSPECTS
> R&D Engineer
> Structural Engineer
> Engineering Consultant
> Expert or managerial position
> Computing project manager

TEACHING STAFF
HEAD OF SPECIALISATION:
Thomas Heuzé
CENTRALE NANTES LECTURERS:
Patrice Cartraud, Nicolas Chevauguen, Pascal Cosson, Laurent Gornet, Thomas Heuzé, Grégory Legrain, Nicolas Moës, Hervé Oudin, Guillaume Racineux, Julien Réthoré, Patrick Rozycki, Rian Seghir, Laurent Stainier
+ faculty from the University of Nantes and external speakers from industry

EXAMPLES OF PREVIOUS INTERNSHIPS
> Simulation of blade loss in a reactor (Snecma)
> Identification of acoustic leakage (Renault)
> Mechanical modelling of fuel assemblies (Areva)
> Dynamics of space launchers (EADS)
> Deployment of space structures (Thalès)
> Simulation in watch-making (Swatch)
> Simulation of the individual movements of a foetus
> Simulation of moving structures (Michelin)
> Reliability and sizing optimisation of a hydro-turbine (HydrOcean).
Acquire skills in computer science and image synthesis as well as in related disciplines that help to build effective immersive applications: cognitive sciences, mechanics and biomechanics, computer vision, human-machine interaction. A comprehensive 500-hour course reflecting the changing needs in virtual reality in business today.

**COURSE CONTENT**

- C++ Programming
- Principles of Virtual Reality
- 3D Real-Time Computer Graphics
- 3D Modelling for Virtual Reality
- 3D Interaction
- Industrial Software Development
- Hands on Virtual Reality
- Computer Vision and Augmented Reality
- First Project in 3D/Computer Graphics
- Collision Detection and Haptic Rendering
- Advanced Concepts in Virtual Reality
- Industrial Conferences
- Scientific Visualization
- Group Project in VR: development of a VR/AR application
EXAMPLES OF PREVIOUS PROJECTS

> Pseudo-haptic feedback
> Augmented reality planetarium
> Automatic gesture recognition through motion capture
> Origami production support in augmented reality
> Capture of the user environment for incorporation in a virtual reality game
> Automatic land generation in 3D
> Production of mini video games in 3D
> Interaction metaphor development for urban design in virtual reality
> Development of a mini serious game for neuropathic pain rehabilitation in partnership with Nantes University Hospital
> Immersive Data Analytics in Unity

INDUSTRY SECTORS

> Aeronautics
> Automotive
> Shipbuilding
> Cinema, video games
> Simulation and VR publishing
> IT Services companies

EXAMPLES OF PREVIOUS INTERNSHIPS

> Development of a brain-computer interface - INSEP, Vincennes
> Augmented Reality operator guidance - CLARTE, Laval
> Therapeutic rehabilitation in Virtual Reality - Motekforce Link, Amsterdam
> Studies and development of augmented glasses - Technicolor, Rennes
> RV / AR Rendering Engine for the Web - Gingalab, Paris
> Augmented reality demonstrator for urban mobility - Sogeti, Aix-en-Provence
> Development of an RV platform for sport - LiveLike, New York
> Development of advertisements in augmented reality - Wipon, Lille
> Ophthalmic correction simulator - Essilor, Créteil
> Augmented Reality for visiting cultural sites - Histovery, Paris

CAREER PROSPECTS

> Virtual reality engineer
> Real-time 3D developer (video games, cinema etc.)
> RV/Augmented reality (AR) applications designer
> R&D engineer
> RV/AR Consultant
> Project Manager (RV / video games)
> Image analysis and design engineer

EXTERNAL PARTNERS:

CLARTÉ
Innia équipe Hybrid*
Airbus*
Renault*
PSA*
Dassault Aviation*
Naval Group*

*During the conference week in Laval

TEACHING STAFF

HEAD OF SPECIALISATION:
Jean-Marie Normand

CENTRALE NANTES LECTURERS:
Damien Chablat, Guillaume Moreau, Jean-Marie Normand, Myriam Servières, Vincent Tourre, Franck Mars, Florent Laroche, Isabelle Milleville, Alban Leroyer

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jean-marie.normand@ec-nantes.fr
DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING

The objective of this specialisation is to train multidisciplinary engineers to design and implement methodological and algorithmic solutions to data processing problems in various industrial application fields. The courses are based on the theory and the practice of methods from computational statistics, applied mathematics, signal and image processing, as well as applied computer science and scientific computing. These courses also offer application-oriented content from healthcare, research and development, imaging science, information and communication technology. This specialisation confers Centrale engineers the skills needed for a professional orientation to research and innovation in industrial and academic fields related to data sciences, audio engineering, industrial imaging, computer-aided decision and biomedical engineering.

AUTUMN SEMESTER
- Scientific computing and numerical optimization
- Signal representation and analysis
- Image processing and analysis
- Statistical data modelling and analysis
- Machine learning
- System identification and signal filtering
- Computational Imaging and inverse methods
- Biomedical signal analysis
- Project in signal and image processing

SPRING SEMESTER
- Biomedical imaging
- Audio content analysis and Information Retrieval
- Multi-sensor data analysis
- R&D applications
- Project in signal and image processing

COURSE CONTENT
INDUSTRY SECTORS

- Data sciences
- Biomedical engineering
- Digital, sound and multimedia
- Industrial R&D (troubleshooting, decision support)
- ICT

CAREER PROSPECTS

- R&D engineer
- Data scientist
- Digital applications design
- Data acquisition and processing project manager

TEACHING STAFF

HEAD OF SPECIALISATION:
Saïd Moussaoui

CENTRALE NANTES LECTURERS:
Sébastien Bourguignon, Diane Mateus, Eric Le Carpentier, Jean-François Petiot

CNRS NANTES:
Jérôme Idier, Mathieu Lagrange

EXTERNAL SPEAKERS:
Oscar Acosta (LTSI, Rennes), Ewen Carcerff (TPAC/DB SAS, Nantes), Thomas Carlier (CHU Nantes), Guy d’Urso (EDF), Bertrand Rivet (GIPSA-lab Grenoble), Laurence Rouet (Philips), Pauline Trouve-Pelloux (Onera), Aurélien Van Langenhove (CHU Nantes)

CONTACT:
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EXAMPLES OF PREVIOUS PROJECTS

- Joint detection-estimation of hymodynamic responses from functional MRI data
- Ultrasound data analysis for depth estimation in non-destructive testing
- Convex k-means clustering from approximate pairwise comparisons
- Unsupervised data clustering for acoustic quality assessment in urban areas
- Implementation of deep learning algorithms for CT scan image segmentation
- Optimization of a Brain-Computer Interface including a Virtual Reality feedback
- Online acquisition and unmixing of hyperspectral images

EXAMPLES OF PREVIOUS INTERNSHIPS

- Short-term audio source separation filter estimation from recurrent convolutional networks (Orange, Rennes)
- Automatic detection of vine rows on aerial images (Avion Jaune, Paris)
- Predicting the risk of delays for the operation of major train stations (SNCF, Paris)
- Correlation between foot and hand movement in pedestrian navigation (IFSTTAR, Nantes)
- Machine learning on biomedical images (CHU Nantes)
- Evaluation of the mental load induced by a brain-computer interface system coupled with virtual reality (OnePoint and CHU Nantes)
- Development of an image processing algorithm for the correction of artifacts in 2D and 3D mammography acquisition (GE Healthcare, The Netherlands)
CIVIL ENGINEERING & SUSTAINABLE CONSTRUCTION

Master the design, construction and operational phases as well as rehabilitation and demolition, taking account of the durability of materials and of environmental risks (e.g. seismic risk).

COURSE CONTENT

SEMESTER 1
- Project Management
- Structural Calculations
- Design and Durability of Materials
- Soil and Rock Mechanics
- Building Physics and Environment
- Case Studies
- Reinforced Concrete Structures
- Geotechnical Engineering
- Project 1

SEMESTER 2
- Eco and Composite Construction
- Earthquake Engineering
- Project 2
- Transport Infrastructure
- Design of Structural Systems
EXAMPLES OF PREVIOUS PROJECTS

> Design and construction of an office building: in response to a call for tenders (Bouygues).
> Behaviour of superficial foundations and piles.
> Design and construction of an underground car park: in response to a call for tenders (Bouygues).
> Modelling of concrete creep in deep storage centres.

EXAMPLES OF PREVIOUS INTERNSHIPS

> Ensuring production quality control for the different phases of pre-stressing.
> Project management – design and operations of Bouygues Telecom site development.
> Project management – underground tunnel construction work.
> Thermo-mechanical modelling of bituminous materials.
> Modelling of a full-scale test of crack growth under traffic on bituminous roads.

INDUSTRY SECTORS

> Public works and buildings
> Construction
> Risk management
> Recruitment across all company sizes from multinationals to national and local SMEs etc.

CAREER PROSPECTS

> Construction project management
> Civil engineering risk management
> Consultancy
> Methods
> R&D in civil engineering

TEACHING STAFF

HEAD OF SPECIALISATION:
Syed Yasir ALAM

LECTURERS:
Syed Yasir Alam, Frédéric Grondin, Benoît Hilloulin, Panagiotis Kotronis, Ahmed Loukili, Anne-Laure Fauchille, Emmanuel Roziere, Giulio Sciarra, Ioannis Stefanou

CONTACT:
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Acquire strong and multidisciplinary scientific skills relating to the physics of city and housing, to meet the major contemporary challenges of city management and design regarding the adaptation to changes and ecological transition. After the core courses, students choose between two options on offer: the Housing option offers specific training for building design; the Urban Engineering option offers training oriented towards management methods of the city and urban environment.

**CORE COURSES**
- Urban issues
- Ecology, city and land
- Construction and structural analysis
- Information systems and databases
- Applied thermodynamics
- Urban hydrology and atmosphere
- Acoustics, light and solar radiation
- Introduction to Building Information Modelling
- Project 1 and 2 Urban issues

**HOUSING OPTION:**
- Building technology
- Thermal performance of buildings
- Air treatment and conditioning
- Materials for housing

**URBAN ENGINEERING OPTION:**
- Energy at the city scale
- Applied urban hydrology and atmosphere
- Management of noise and soil pollution
- Planning and transport
EXAMPLES OF PREVIOUS PROJECTS

> Indicators for Eco-districts
> Drinking water network
> Regional energy efficiency
> Energy consumption forecast (Nantes Métropole)
> Energy study of a village (Saint-Fiacre sur Maine)
> Urban mobility diagram
> Car-free city
> Olympic Games and World Cup: impact on the urban development of Rio de Janeiro
> Structural calculation of a hotel in Lebanon
> Comparative study of wood vs. concrete house
> Thermal performance of buildings: case study
> Design of a bioclimatic childcare centre (architecture competition)
> Sustainable house
> Implementation of E+ C- regulations (Bouygues)

EXAMPLES OF PREVIOUS INTERNSHIPS

> Construction site (Bouygues Construction) to renovate the Santé prison in Paris
> Sustainable development approach (Guarani - Brazil)
> Management of urban development projects (ARTELIA)
> RE 2020 and low carbon construction (Bouygues Bâtiment)
> Energy design of the hospital center of Tours (AIA Ingénierie)
> Methodology to support designers in reducing the urban heat island effect (OASIIS)
> Energy instrumentation of Singapore Sport Hub (DG Energy Control, Singapore)
> Design of an urban transport project (INGEROP Conseil & Ingénierie)
> Infrastructure for the renovation of a tramway line (SEMITAN)
> Thinking buildings as materials banks in Sweden (Anthesis Sweden AB)
> 3D modeling of infrastructure elements and definition of BIM solutions on the 3Dexperience platform (Dassault Systèmes)
> Deployment of digital tools for operating water networks (VEOLIA Eau)
> Reliability and optimization of the dimensioning calculation tools for piles and mini-piles (Soletanche-Filiale VINCI)

INDUSTRY SECTORS

> Engineering consultancy
> Inspection and certification bodies
> Technical centres
> Local and regional authorities
> Specialist Institutes
> Large groups for urban development and service

CAREER PROSPECTS

> Engineer in thermal technology and energy efficiency of buildings
> Engineering consultant in urban engineering
> Construction site engineer (new build / renovation)
> Consulting engineer in sustainable development, energy-building, environmental performance of projects, etc.
> Urban development and innovations project manager

TEACHING STAFF

HEAD OF SPECIALISATION:
Isabelle Calmet

LECTURERS:
Isabelle Calmet, Patrice Cartraud, David Chalet, Jean-François Hétet, Jean-Yves Martin, Pierre Marty

EXTERNAL SPEAKERS:
CEREMA
BRGM
Saunier Duval
WSP
SARATEC
Akajoule
Bouygues
ESO

CONTACT:
isabelle.calmet@ec-nantes.fr
2ND AND 3RD YEAR SPECIALISATION

DIGITAL CITY
GEOMATICS AND URBANISM

Understand the city through the creation and use of its digital twin:

- Analyze, model, process and represent urban data from acquisition to decision-making
- Address the complexity of urban systems, their stakeholders and processes for sustainable management of "smart" cities.

COURSE CONTENT

GEOMATICS
- Geographical Information Systems (GIS)
- GIS Engineering
- Modelling and use of urban data
- Information systems and databases
- Introduction to Programming
- Image analysis and processing
- Project 1

URBANISM
- Urban issues
- Urban models
- Building Information Modelling
- Urban policies
- City representation
- Project 2
INDUSTRY SECTORS

- Local or regional authority
- Planning agency (AURAN, IAU etc)
- Urban engineering consultancy
- Companies in the digital sector such as Cap Gemini, Sopra, IBM
- Architecture, engineering and building firms: Suez, Vinci Construction, GRDF, Artilia
- Research bodies (IGN, CNRS)

CAREER PROSPECTS

- Urban data officer
- Geomatic engineer
- ‘Smart city’ project manager
- Heritage project manager
- Planning engineer
- BIM manager

TEACHING STAFF

HEAD OF SPECIALISATION:
Myriam Servières

LECTURERS:
Jean-Marie Normand, Jean-Yves Martin,
Guillaume Moreau, Said Moussaoui, Myriam Servières,
Vincent Tourre

LECTURERS ENSA NANTES/AAU CRENAU:
Ignacio Requena-Ruiz, Pascal Joanne, Laurent Lescop,
Daniel Siret

EXTERNAL SPEAKERS
Gwendal Petit (UBS), Gilles Gesquière (LIRIS),
Valérie Renaudin (Gustave Eiffel University),
Laurent Vigneau (Artilia), Hugo Mercier (Oslandia),
Nicolas Chavent (OSM), Matthieu Mosser (Siradel),
Carole Bodilis (Open Data Soft)

CONTACT :
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https://www.linkedin.com/groups/12049080/

EXAMPLES OF PAST PROJECTS

- A dynamic interface for analyzing the public transport network load in the Nantes conurbation (in partnership with AURAN)
- Definition of indicators for urban ambience (with the research laboratory CRENAU)
- Development of indicators for 3D urban data (with Oslandia)
- Representation of mobility and accessibility using an interactive 3D isochronous representation (with Siradel)
- Cartographic representation of a pollution sensor dataset on Rennes resulting from a collaborative acquisition
- Decision support, electrical power calculator and cartographic proposal for a tool for the electrical supply of real-estate projects (with Nantes Métropole)

EVENTS

- CityLab Alliance with 10 partner companies.
- Workshop Mobiance: pedagogical research workshop on Mobility, Ambiances and Urban Design.

EXAMPLES OF PREVIOUS INTERNSHIPS

- Design, build and integration of GIS (Sopra Nantes)
- Creation of an IT tool for feedback and testing of geomatic techniques for decision-making in order to prioritize the handling of industrial risks. (GrdF Paris)
- Construction of 3D models, design and administration of spatial databases and development of operational tools (ForCity)
- GIS/Smart Cities Consultant (Sopra)
- GIS configuration of roadside trees (local authority)
- Design and implementation of a style model adapted to a 3D web application (IGN-COGIT)
- BIM Development in Digital Services (Vinci Construction)
- Construction of BIM digital heritage and management of real estate databases (Foundation)
- Development of an urban planning GIS (city of Redon)
- Cartographic retranscription of illumination measurements (SPIE)
Provide the students with the scientific and technical knowledge in hydrodynamics and ocean engineering to allow them to address societal issues linked mainly to energy (offshore oil, marine renewable energies) and maritime transport (building of environmentally-friendly ships and transport of offshore wind turbines).

**COURSE CONTENT**

- General Concepts of Hydrodynamics
- Water Waves and Sea States Modeling
- Wave-Structure Interactions & Ship Stability
- Numerical Hydrodynamics 1
- Moorings & Manoeuvrability
- Experimental Hydrodynamics
- Lifting Profiles
- Numerical Hydrodynamics 2
- Ship Structure & Maritime Economy
- Fluid-Structure Interactions
- Focus on Optimization, Sailing Ship & Simulations
- Marine Renewable Energy & Oil&Gas
- Project 1 and 2
EXAMPLES OF PREVIOUS PROJECTS

> Numerical simulation of cylinders for riser sizing (HydrOcean)
> Numerical study of the aerodynamic performance of a vertical axis wind turbine (LHEEA)
> Influence of anchor modelling on the performance of a wave energy convertor (Innosea)
> Design and build of two electrically propelled boats (Hydrocontest student competition)
> Exploratory study for the deterministic measurement and prediction of sea states (LHEEA)
> Architecture of a floating wind farm (LHEEA)
> Characterization of the small wave tank (LHEEA)

EXAMPLES OF PREVIOUS INTERNSHIPS

> Hydrodynamic study of a sailing project, K-epsilon, Sophia Antipolis.
> Naval design and engineering studies, Marc Lombard, La Rochelle.
> Study of models using coastal environment software MIKE FM (DHI, Denmark)
> Offshore data analysis and study of anchor line fatigue (Exeter University, UK)
> Modelling of the dynamic behaviour of an anemometer (Ecole Navale, Brest)
> Calculation in the naval field, Segula Engineering, Saint-Herblain.
> Study of an offshore facility (Innosea, Edinburgh, UK)

INDUSTRY SECTORS

> Offshore oil
> Marine Renewable Energies
> Naval engineering
> Maritime transport
> Research (private or public sector)
> Coastal engineering
> Numerical simulation in hydrodynamics and fluid mechanics

CAREER PROSPECTS

> R&D engineer
> Installation and operations engineer (MRE offshore)
> Project engineer
> Quality engineer
> Production management engineer
> Supply chain manager

TEACHING STAFF

HEAD OF SPECIALISATION:
Félicien Bonnefoy

CENTRALE NANTES LECTURERS:
Sandrine Aubrun, Félicien Bonnefoy, Isabelle Calmet, Antoine Ducoin, Guillaume Ducrozet, Pierre Ferrant, David Le Touzé, Zhe Li and researchers from the Research Laboratory in Hydrodynamics, Energetics & Atmospheric Environment (LHEEA)

EXTERNAL SPEAKERS:
Academics: Université de Nantes, École navale (Brest), ICAM Nantes
Naval architecture: HT2
Marine Renewable Energies: Innosea, EDF-EN, Naval Group
Offshore oil: Principia, Total, Saipem, Subsea 7

CONTACT:
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Improvements in energy efficiency, the development of renewable energies and energy storage are amongst the main challenges facing engineers today. It is within this context that this specialisation aims to provide general engineering students with the skills to deal with cross- and multi-disciplinary issues linked to energy. The following fields are covered:

- conventional energy production
- renewable energy production (wind, solar and thermal power...)
- energy management, transport and storage
- efficient use of energy particularly in industry and construction
- consideration of the environmental constraints linked to energy (depollution of energy production systems).

**COURSE CONTENT**

- Combustion
- Thermodynamics
- Turbomachinery
- Thermodynamics applied to cycles
- Conventional energy production
- Low carbon energy
- energy transportation and storage
- Labs in energetics
- Building thermal studies
- Air treatment and climatisation
- Solar energy
- Carbon footprint and energy audit
- Project 1 and 2
SECTORS OF ACTIVITY & EMPLOYMENT PROSPECTS

A wealth of employment prospects exist across industry:

- Traditional energy production sector (EDF, Areva, GDF Suez, TOTAL, ALSTOM, ENI, E.ON)
- Renewable energy production sector (Areva Solar, Naval Group, ALSTOM, SIEMENS, GE Wind Energy, Gamesa, REPower, Enercon, ...)
- Energy transport sector (RTE, Direct Energie, GrDF, ENI)
- HVAC sector (Saunier Duval, GEA, Daikin, A2P, ...),
- Energy-consuming industries aiming to reduce their energy bill (SNCF, Saint Gobain, ArcelorMittal, Air Liquide, ...)
- Engineering and design consultancies specialising in thermal comfort and building energy (Indigo, Alterea, Altereco, ...)
- National and international bodies promoting the development of renewable energies, and energy research centres (CEA, IFPEN)

EXAMPLES OF PAST PROJECTS

- Design, production and testing of a thermal solar collector
- Study on inter-seasonal heat storage
- Study on concentrated solar power
- Integration of forecasted weather data into the energy control system of the Solar Decathlon prototype
- Thermal study of housing (steady-state calculation and dynamic thermal simulation)
- Study of a cogeneration system and combined cycles
- Study of an ocean thermal energy system

EXAMPLES OF PAST INTERNSHIPS

- Assistant Solar Project Manager (JP Energie Environnement)
- Consultant in Carbon and Energy Transition Strategy (Carbone 4)
- Heating and air-conditioning installation study and works
- Energy optimization for a rotary kiln: experimental development of an innovative heat exchanger (IFSTTAR)
- Study and improvement of tomorrow’s power grid (RTE)
- Integration of wind turbines into the electricity market (Maïa Eolis)

TEACHING STAFF

HEAD OF SPECIALISATION:
Jean-François Hétet

CENTRALE NANTES LECTURERS:
David Chalet, Pascal Chessé, Jean-François Hétet, Thierry Jaszay, Alain Maiboom, Vincent Berthome, Xavier Tauzia

EXTERN SPEAKERS:
EDF, Cohérence énergies, Valéo, IFPEN, RTE, ENGIE, GRT Gaz, CEREMA, INDIGGO, Saunier Duval EM2C, LHEEA, IMN

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The blend of skills acquired will allow students to get to grips with propulsion systems in their entirety, using an energy-based approach (modelling, experimentation and simulation), and covering the technical, economic and environmental challenges. The originality of this specialisation lies in its multi-disciplinary nature (thermodynamics, gas dynamics, combustion, optimisation).

**COURSE CONTENT**

- Combustion and pollutant emissions
- Turbomachinery
- Applied thermodynamics
- Internal combustion engines
- Gas dynamics
- Energy management in automotive applications
- Aeronautical propulsion
- Automotive propulsion
- Marine propulsion
- Space propulsion
- Railway engineering
- Practical work in propulsion
- Projects
EXAMPLES OF PREVIOUS PROJECTS

- Influence of the geometry of an intake line on the performance of an internal combustion engine
- 0D modelling of a thermo-fluid system and experimental validation
- Improvement in the experimental setup of a turbojet bench
- Energy optimisation on-board ship

EXAMPLES OF PREVIOUS INTERNSHIPS

- Arianespace: 0D / 1D fluid modelling of a cryogenic upper stage (ESCA) for Ariane 5
- Mann+Hummel: Improvement in thermal simulation of an internal combustion engine through nodal modelling of the cylinder block and head
- Safran: Kinematic study of the control system with variable valve high pressure compressor
- Manitou: Study and modelling of an engine / transmission / hydraulic control solution for a telescopic forklift truck in order to optimize the vehicle’s energy resources
- AVL: Engineering on engine test bench
- CMT: Analytical and experimental study of automotive turbocharged engines
- Renault Formula 1: Study and development of water, oil and air regulations in order to simulate F1 engine behaviour during a lap
- PSA: Combustion modelling for spark-ignition engines
- STX: Reduction of the pollutant emissions for a ship
- Semitan: Determination of the natural gas consumption of buses
- Eco-Drive, high-speed train simulator (Alstom)
- Experimental study and control of a multi-evaporator air-conditioning system for cabin and battery cooling (University of Liège)
- Research into pre-design rules for space turbo pumps (CNES)
- Development of an engine simulation model (Volvo Trucks)

INDUSTRY SECTORS

- Energy-related propulsion
- Automotive
- Aeronautics
- Aerospace
- Naval
- Railway
- Design office

CAREER PROSPECTS

This specialisation gives access to numerous professions in the automotive, aeronautical, space, maritime and railway sectors:

- Design engineer
- Modelling and optimisation engineer
- Test engineer
- Technical marketing engineer, etc.

TEACHING STAFF

HEAD OF SPECIALISATION:
Georges Salameh

CENTRALE NANTES LECTURERS:
Vincent Berthomé, David Chalet, Pascal Chessé, Jean-François Hétet, Pierre Marty, Alain Maiboom, Laurent Perret, Georges Salameh, Xavier Tauzia

EXTERNAL SPEAKERS:
Academic: Centrale Paris, University of Nantes, etc.
Industry: Renault, PSA, MANN+HUMMEL, Honeywell, IFPEN, Alstom, Arianegroup, Safran, MAN Energy Solutions

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A cutting-edge programme in the transdisciplinary field of digital science and technologies (information processing and communication) applied to life sciences and healthcare technology.

Medicine, in particular, has moved into the Big Data age with the ramping up of high speed data for diagnosis and therapy. Biotechnologies are expanding significantly in fields such as green chemistry, the use of bacteria for biofuel synthesis, soil decontamination, the development of new biomaterials.

**COURSE CONTENT**

**LIFE SCIENCES:**
- Cellular biology
- Immunology
- Molecular biology, genetics, evolution
- Neurology and physiology

**LIFE SCIENCES AND DIGITAL SCIENCES:**
- Bioinformatics, genomics and “big data”
- Systems Biology: Discrete Modelling and Qualitative Analysis of Biological Networks
- Systems Biology: Probabilistic Modelling and Quantitative Analysis of Biological Networks

**DIGITAL SCIENCES:**
- Operating Systems and Databases
- Statistics and Machine Learning
- Computational Surgery
- Advanced Informatics

**CONFERENCES AND PROJECTS**
- Conference cycle
- Supervised project
EXAMPLES OF PREVIOUS PROJECTS

> Microbial Synthetic Biology for Human Health (Analysis of microbial communities in the gut by using Multi-criteria constraint based methods. Promoting the use of probiotic therapies via optimization based-protocols (LS2N/COMBI, UMR 6004, Nantes)
> Contribution on learning time series data and analysis of dynamic models for participation in the DREAM11 Challenge (LS2N/MeforBio, UMR 6004, Nantes)
> Kinetic descriptions of the theory of evolution (ICI, Nantes)
> Single cell approach in cancer genomics and epigenomics: from cellular microfluidic purification to bioinformatics data analysis (CRCINA, UMR_S 1232, Nantes)
> Marker imputation in genetics or the move from the lab to ‘in silico’ (ITUN - CRTI – UMR Inserm 1064 –Nantes University Hospital)
> Image registration for two types of acquisition mode: fluorescence and beta-type radioactive imaging (SFR Santé François Bonamy UMS 3556 IRS-UN, Nantes)
> Machine Learning research on the automation of dermoscopic image recognition (Nantes University Hospital)

EXAMPLES OF PREVIOUS INTERNSHIPS

> Differentiation of T1 and T2 breast tumours by DNA methylation markers based on whole-genome bisulfite sequencing (CEA, Paris)
> Reduced order modelling for flexible prosthetic robots (University of Saragossa, Spain)
> Study of the long-term variability of DNA methylation (at the genome level) (INSERM, Lyon)
> Analysis of large-scale multi-dimensional genetic data (Institut Pasteur, Paris)
> Testing optimal control models of human saccadic eye movements (Radboud UMC, Nijmegen, Netherlands)
> Implementation of a protocol for a new skin imaging method (Laboratoire Clarins, Paris)
> Test the hypothesis of background genetic variation being a contributor to the off-target effects of CRISPR (Cancer Research UK, Cambridge Institute, UK)
> CNV detection from targeted sequencing data (Assistance Publique - Hôpitaux de Paris)
> Flow/mass cytometry and next-gen sequencing analysis (CLIP Laboratory, Prague, Czech Republic)
> Development and optimization of a compressed-sensing reconstruction algorithm to accelerate the acquisition of MRI images. Application for the detection of metastases. (CRMSB CNRS, Bordeaux)
> Simulation and study of neurons and their networks (CNRS, Lille)
> The role of normal and cancer RNA levels in the causation of colorectal cancer (Roslin Institute, Edinburgh, UK)
> Contraction of metabolic networks (Freie Universität Berlin, Germany)
> Multiplex PCR reaction modelling (bioMérieux, Marcy l’Etoile).
Centrale Nantes offers a doctorate option to final year students who are attracted to the sciences and want to turn progressively towards research, developing expertise in order to embark upon a PhD.

The aim of this option is to propose a research pathway to students who wish to pursue a PhD. Thus, students devote most of their final year of study to commencing research work which they will then pursue with a PhD at Centrale Nantes. Centrale Nantes thus offers a suitable course and naturally leads students who wish to engage in research towards a PhD.

FROM SEPTEMBER TO THE END OF MARCH:
>
- Research work, replacing the specialisation
- Professional option
- Modern language classes and sport

FROM APRIL UNTIL THE END OF SEPTEMBER:
>
- 6-month full-time paid internship on the thesis subject. The internship can be undertaken in a laboratory outside Centrale Nantes (including abroad), or in a company.
RESEARCH LABORATORIES

Centrale Nantes hosts six laboratories on campus in collaboration with the CNRS (the National Center for Scientific Research) and other institutions such as Nantes University and Institut Mines Télécoms:

- Research Laboratory in Hydrodynamics, Energetics & Atmospheric Environment - LHEEA
- Laboratory of Digital Sciences of Nantes - LS2N
- Research Institute in Civil and Mechanical Engineering - GeM
- Urban Architecture Nantes Research Centre - AAU
- Jean Leray Mathematical Institute
- High Performance Computing Institute - ICI

Our laboratories work on the three challenges for growth and innovation: manufacturing, health and energy transition. Their thematic coverage is therefore vast and heightens the versatility of our training programmes.

EXAMPLES OF PHD THESES

- Ontological engineering for the creation and management of adaptive teaching resources.
- Behaviour of recycled concrete at earlier and later ages: influence of initial water saturation and substitution rate.
- Contribution to understanding the mechanisms of passivation in concrete reinforcements exposed to seawater: theory and thermochemical modelling.
- Virtual reality tools for universal design
- Advanced methods and multi-scale analysis for the study of the self-healing of cracks in cementitious materials.
- Ego-centred representations for the autonomous navigation of a humanoid robot.
- Influence of image features on face portraits - social context interpretation: experimental methods, crowdsourcing based studies and models.
- Deterministic modelling of large-scale sea states at variable depths.
- Predictive control and estimation of uncertain systems with delayed input.
- Model reduction method for parametric equations - Application to the quantification of uncertainty.
- Input-state linearization and decoupling of nonlinear systems with delays

INDUSTRY SECTORS

- Industrial R&D
- Academia

TEACHING STAFF

HEAD OF SPECIALISATION:
Jean-Yves Hascoët

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In the run-up to the Paris 2024 Olympic and Paralympic Games, Centrale Nantes created the Scientific Challenge 2024 project-based specialisation in September 2018 in partnership with the CREPS des Pays de la Loire and the French Rowing Federation, in order to improve physical and technical expertise in rowing. This project is in line with research work conducted in the LHEEA and performance support for water sports.

The Simulator of Performance in Rowing (SPRing) has thus been developed: a high-fidelity simulator of the complex boat-oar-rower system, which aims to establish objective criteria to respond to problems experienced in the field and guide decision-making for coaching staff.

**COURSE CONTENT**

**1st Period**
- Project Scoping
- Scientific and technical courses
- Appropriation - I

**2nd Period**
- Appropriation - II
- Advanced and specialised courses
- Work on deliverables - I

**3rd Period**
- Work on deliverables - II
- Promotion / Publication
- Drafting of end of project documents: handover, comm, review etc
- Presentation of results

List of Courses (~100 hours)
- Project Management
- Tool for Scientific Computing and HPC 1
- From reality to 3D model
- Numerical modelling, CFD and FSI
- Tool for Scientific Computing and HPC 2

The rest of the time is devoted to independent project work:
- Framework and appropriation
- Simulator development
- Studies and responding to field issues
- Completion and review
This innovative project-based teaching method will allow students to acquire competences in a different way thanks to:

- A customised training programme (100 hours of courses)
- Agile and autonomous organisation
- Tailored support
- Immersion in the world of sports engineering
- Scientific challenges linked to industrial issues (naval hydrodynamics, MRE, digital simulation, 3D modelling etc.)
- An opportunity to take concrete action on an ambitious performance support project in the run up to the 2024 Paris Olympics

The first three cohorts of the specialisation have successively:

1. developed the first version of the simulator and demonstrated its feasibility
2. improved its functionality to make it more accurate and realistic
3. automated the whole calculation sequence to make the simulator operational in terms of production

The objectives for the year 2021/2022 are as follows:

- To get to grips with the simulator and confront it with the reality in the field in order to provide initial insights and to guide coaches and rowers in their decision-making
- Undertake additional developments on the simulator, mainly with regard to kinematic modeling of the rower, additional variables to be analyzed and realistic visual rendering.
- To run training sessions for coaches in particular with simulation results that tangibly illustrate the mechanical laws governing oar propulsion.

Project-based learning is highly valued by companies. Student internships are quite varied, and reflect the diversity of backgrounds.

- Development of hydrodynamic meta-models and CFD validation, Artemis Technologies, UK
- Graphic reconstruction of an electronic horizon, Renault Software Labs, Sophia-Antipolis
- Executive Assistant: Project Management and Financial Reporting, Haemers Technologies, Brussels
- Thermo-hydrodynamic modelling on a heat exchanger, Naval group, Nantes
- Numerical simulation of ship maneuvers, Numeca Int., Brussels,
- CAD and subsystem design of the ‘Heron Tree’, Les Machines de l’île, Nantes

Centrale Nantes is a French engineering school and member of the Ecoles Centrale Group. Its graduate, master and PhD programmes are based on the latest scientific and technological developments and the best management practices. Founded in 1919, Centrale Nantes 42-acre campus welcomes 2,320 students, including 1,950 graduate students, 150 Executive Education and degree apprenticeship students, 240 PhD students and 380 Master and Advanced Master students.
The aim of the project is to develop a model of an Android mobile application which allows the user to:

- define a route in the Nantes Métropole area,
- select a mode of transport (pedestrian, bicycle, car, public transport),
- calculate or estimate the user's environmental exposure on the journey,
- receive recommendations based on his/her profile and the probability of impact on his/her health of said environmental exposure.

### COURSE CONTENT

- Introduction to Programming
- Information systems and databases
- Geographical Information Systems (GIS)
- Android programming
- Scientific computing and numerical optimization
- Statistical data modelling and analysis
- Acquisition of scientific data on air quality
- Specifications and UML

- Project Management
- Project scope and data capture
- App programming and rollout
- Mobility and route planning
- Respiratory health and environmental exposure
- Design and development
- Rollout and promotion
- Expert project intervention
1. Knowledge and skills-based learning:
   - Data capture, analysis, calculation, optimisation, modelling, simulation, air quality (linked to Data Analysis and Applications specialisation, Gustave Eiffel University, Air PDL);
   - Development of mobile geographic applications (linked to Digital City and Computer Science specialisations);
   - Transport, Mobility and Itinerary Planning (linked to Air Quality Research - David Chalet, and SLP Research Group in the LS2N Laboratory);
   - Respiratory Health (Partnership with Nantes University Hospital, Professor Magnan, Professor Blanc);
   - Project (scoping, design, development, validation, training, deployment, promotion, operation)

2. Data capture
   - Data collection:
     - Nantes Environment: Air PDL
     - Cartography: Open Street Map (for example)
     - Health: Nantes University Hospital
   - Scientific testing on a multi-transport itinerary (Hôtel Dieu to ECN by car, bicycle, on foot, bus, tram, etc). Link with Gustave Eiffel University, Research conducted by David Chalet, Matisse Lesage and Julien Cario
   - Patient data testing (from patient file to user profile, connected health objects and partnership with Nantes University Hospital)

3. Application development
   - Specifications
   - Development (design, developments, validation, production, operation)

4. Promotion and handover
   - Scientific publication
   - Presentation of results
   - Communication on results and methods employed
   - Consolidation for handover

PROJECT PHASES

OVERVIEW
The Environment Mobility Health project specialisation is proposed in partnership with Nantes University Hospital, within the framework of innovative projects focusing on respiratory health, led by Professor Antoine Magnan, president of the establishment’s medical community, and Professor François-Xavier Blanc, Head of Respiratory Care. The project is a specific component of the work of the IRC Lung O2. The specialisation brings together the technological expertise of Centrale Nantes (data analysis and applications, digital city, IT, mobility, etc.), Gustave Eiffel University (environmental measurements, particles, etc.), Nantes University Hospital (respiratory health), and Air Pays de la Loire (environmental exposure).

Finally, the option is fully in keeping with the following strategic objectives at Centrale Nantes:
   - deliver project-based teaching;
   - set up innovative and engaging methods of learning for our students;
   - firmly anchor health within our programmes alongside our main partner: Nantes University Hospital;
   - focus on environmental impact and ecological transition within the curriculum.

COURSE ARRANGEMENTS
A group of up to 12 students will follow the specialisation from September 2020 to March 2021. The students will be divided into two groups of expertise: programming and data collection.

The project specialisation comprises:
   - Project work supervised by the head of the specialisation;
   - Scientific classes on the fundamental subjects;
   - Scientific supervision from the partners (Nantes University Hospital, Gustave Eiffel University, Air Pays de la Loire).

TEACHING STAFF
HEAD OF SPECIALISATION:
Thomas Lechevallier

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Centrale Nantes is a French engineering school and member of the Ecoles Centrale Group. Its graduate, master and PhD programmes are based on the latest scientific and technological developments and the best management practices. Founded in 1919, Centrale Nantes’ 40-acre campus welcomes 2,320 students, including 1,950 graduate students, 150 Executive Education and degree apprenticeship students, 240 PhD students and 380 Master and Advanced Master students.
It’s now a matter of real urgency that we understand and have others understand that the global warming is not mere opinion, but scientific reality. In order to limit global warming to 1.5°C, the IPCC concludes that we must reduce our CO2 emissions by 45% (from 2010 levels) by 2030, reaching ‘net zero’ by the middle of the century.

This project specialisation is designed for students to take action to support the school - and more broadly, society - in reducing its carbon footprint. Students will be fully immersed in this topic on a daily basis, affording them the knowledge and skills to take action on this issue during their professional careers.

**COURSE CONTENT**

Support the school in a decarbonization approach aligned with national and international commitments:

- Understand climate change and science-based targets,
- Assess the school’s carbon footprint and evaluate actions to reduce the CO2 emissions,
- Produce effective management tools, directly usable by Centrale Nantes Departments and Committees to design and implement action plans,
- Develop digital tools allowing each user to calculate their carbon footprint and identify their ways to act on campus,
- Raise awareness about climate issues among students and school staff,
- Develop a platform accessible to other institutions to support them in their ecological and solidarity transition process,
- Communicate and share the work carried out in order to guide as many people as possible to reduce their carbon footprint.
Project-based learning allows students to acquire different skills through:

- A tailor-made training programme that adapts to the needs of students,
- Agile and autonomous organisation,
- Tailored support,
- An opportunity to take concrete action on a current and global issue,
- Full immersion in ecological and climate themes.

**Project Deliverables**

- Carbon footprint of Centrale Nantes and quantification of the emission reduction actions from the ADEME QuantiGES protocol,
- Tool for calculating decarbonization trajectories adapted to Centrale Nantes and aligned with international science-based targets,
- Development of standardized or automated data collection and analysis systems (sensors, counters, etc.),
- Tools to measure the school’s carbon footprint and also one’s individual carbon footprint to encourage others to act collectively,
- Workshops and support media to raise user awareness and disseminate knowledge,
- Regular project monitoring deliverables (minutes, progress reports and indicators, planning etc.).
Professional options in year 3

- Healthcare Engineering (new for 2020/21)
- Personal Project
- Entrepreneurship
- Business Finance
- International Business Development
- Engineering for Ecological Transition
- Engineering and digital sciences for art, culture and heritage
- Manager, Leader, Communicator
- Research and Development
- Science and Music
- Disrupt’ Campus Nantes
HEALTHCARE ENGINEERING

The Healthcare Engineering option is entirely in keeping with Centrale Nantes' focus on 'engineering for health' and 'industry of the future', preparing students for engineering professions in the healthcare sector.

OBJECTIVES

- Understand health challenges for patients, the general public and the health sector,
- become familiar with the underlying health principles in France, Europe and the world,
- anticipate developments in the health sector through new technologies,
- pursue a career in the public or private hospital sector,
- manage urbanisation of current or future information systems,
- to understand the industrial players in the health sector,
- to take part in technical and organizational projects alongside committed stakeholders.

COURSE CONTENT

- Health: the fundamentals of medicine, population health and its political and societal organization
- Engineering in hospitals: digital, biomedical, research, logistics, works, quality
- Engineering in healthcare companies: drugs, imaging, biomedical devices, information systems, construction, consulting, etc.
- Health (hospital, private, public and industrial) projects.

HEAD OF OPTION

Thomas Lechevallier

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The objective of this option is to provide a framework for our students to be more present and active in economic, philanthropic or associative projects (including humanitarian work, NGOs...) in order to help prepare their entry into the workforce and integration in society at large.

The aim is to develop the future engineer’s initiative through a project which capitalises on both academic studies and personal initiative.

A maximum of six projects per intake are accepted subsequent to a selection process. Throughout the project students are closely accompanied by a member of faculty and regular sessions are organized to bring the participants of the different projects together.

> Building of a new school in India - communication and funding campaign
> Feasibility study for setting up a company in Madagascar
> Preparation for a transatlantic yacht race
ENTREPRENEURSHIP

- Budding entrepreneur?
- Looking to assess the viability of a business project?
- Keen to know how to create a subsidiary within an existing group?

... the Entrepreneurship option is designed for you!

OBJECTIVES

- Develop skills and behaviour conducive to professional success
- Understand the rudiments of management
- Acquire various skills related to business creation (marketing, negotiation, management, legal aspects, strategy, etc.)

COURSE CONTENT

- Start-up methodology
- Strategy
- Finance plan
- Legal specificities of the development of small or medium-sized companies
- Taking over a company
- Leadership Management
- Marketing, Creativity, Negotiation
- Entrepreneurial Project

TEACHING METHODS & ASSESSMENT

- Conferences and meetings with entrepreneurs
- Lectures, practical exercises, role-playing, case studies
- Continuous assessment with individual and group evaluations

HEAD OF OPTION
Pascal Gilquin

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EBITDA, ROC, FREE CASH FLOW ... confused about these financial terms? Your future cross-functional responsibilities will inevitably require you to speak finance ...
Solid business finance skills will guarantee you see the full picture in your future post!

OBJECTIVES

> Teach future engineers how to use accounting and finance documents in decision making. This requires an understanding of accounting methods and principles, financial analysis tools and techniques, strategies employed for the presentation of financial data, and the questions businesses may have concerning their financial structure, investments, profitability and their shareholder policy.
> Prepare students, from both a professional and an academic standpoint, for careers with a high degree of responsibility.

COURSE CONTENT

> **Accounting**: the objective is to understand the balance sheet, profit and loss account, cashflow statement, international standards, changes in equity, account consolidation.
> **Introduction to financial analysis** - margins, working capital requirement, investment needs, financing, profitability.
> **Corporate financial policy** - corporate value, financial structure, investment policy, funding, equity capital, financial engineering.

HEAD OF OPTION
Pascal Gilquin

CONTACT
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If you have a taste for the business side of the engineering industry this course could be for you.

The aim of the course is to give you an introduction to some of the skills required to grow a business internationally. A business development manager has the key role of understanding the technical side of the business, growing the business over time and dealing on a face to face basis with clients.

The option is run in English and the subjects are taught in a mix of English and French.

**COURSE CONTENT**

- **Sales and Prospecting:** Focuses on the key skills needed to find new customers and to build and maintain a loyal client base.
- **Finance:** An introduction to analysing financial statements, valuing projects, the specialist area of project finance, how companies raise funds and the financial risks international companies face and how these risks can be mitigated.
- **International Markets:** Strategies used to develop into international markets and how international markets differ from the domestic market in terms of language, culture and market structure.
- **Negotiation:** The communication techniques needed to build long term client relationships so that companies and their customers can find the middle ground where business can flourish.
- **Business Law:** Real life examples of business and contract law to better understand the importance of this crucial area when companies and clients wish to work together.
- **Project:** A business development project working alongside a company in various engineering fields.
EXAMPLES OF PAST PROJECTS

- Orange: The objective of the project was to undertake a market study of how companies use the internet to provide services to their clients, especially with SD-WAN (software defined wide area network). Orange wanted to better understand businesses’ needs for this type of service and have an objective overview of what their competition is offering in this sector.

- Labbe Process Equipment: a medium sized engineering company specialising in the manufacturing of industrial equipment. The objective was to identify potential new international markets where Labbe could market a new product, a heat exchanger WEplex. The study focused on North and Central Africa and Latin America.

- Cyberwatch: Cyberwatch wants to expand its business into new markets in Europe but also further afield and asked the team to identify several countries where its services could be developed.

- XSun: a start up in the incubator at Centrale Nantes that has developed an autonomous drone. The group’s objective was to identify countries around the world where forest fires are a great risk, study the rules and regulations of those countries regarding the use of drones and then to identify potential new clients that XSun could approach with their innovative technology.

SECTORS OF ACTIVITY

- Building sector
- Telecoms
- Energy
- IT
- Engineering consultancy

CAREER PROSPECTS

- International business development engineer
- Technical sales engineer
- Key account manager
- Export manager
- Business development manager

TEACHING STAFF

HEAD OF OPTION

Julien Beck

EXTERNAL SPEAKERS

Nicolas Guilloux, Anne-Francoise Webster, Jean-Claude Lhommeau

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This option aims to train responsible engineers. They must be capable of imagining and designing new ways of consuming, producing, working and living together. Two concepts will be studied in order to meet this objective:

- **The circular economy** - moving from a so-called linear economy to a virtuous circular model in order to produce goods and services that drastically reduce the consumption and waste of raw materials, the production of waste and the use of non-renewable energy.

- **Eco-design** - integrating the environment from the design stage of a good or service, and at all stages of its life cycle to reduce the harmful effects of climate change, depletion of the ozone layer, air and water pollution, toxicity and waste generation.

**COURSE CONTENT**

- Challenges and stakeholders in ecological transition
- Circular economy - the fundamental principles
- Eco-design - reducing carbon footprint and life cycle considerations
- Ecological Transition Mornings with expert speakers

The teaching programme comprises lectures, company visits, speakers from industry, participatory workshops, case studies and industrial projects.
EXAMPLES OF PAST PROJECTS

- Organising the Ecological Transition Mornings
- Participation in the Pays de la Loire Sustainable Development Trophy panel
- Eco-design of a mushroom farm
- Life cycle analysis of catering packaging (Nantes Métropole)
- Carbon balance of a foundry (Lemer)
- Low-tech goods assessment tool (University of Nantes)
- Functional economy: student furniture in Nantes (Pays de la Loire Region)
- Implementation of a self-diagnostic tool on the circular economy
- Creation of educational materials on the circular economy

EXAMPLES OF PAST INTERNSHIPS

- Rethinking the business model around an eco-designed folding bike (Decathlon)
- ‘Cradle to Cradle’ - a step towards the resource paradigm - application to building (Upcyclea)
- Carry out a complete carbon balance for the Sonceboz Group (Switzerland)
- Create a decision support tool to define the optimum time to refurbish or dismantle material handling equipment (Manitou)
- Consulting and assistance with project management in waste management (Sage Services)
- Development of decision support tools for the development of anaerobic digestion (Akajoule)
- Inert waste from construction sites and the circular economy: Study of a recycling sector (Nantes Métropole)
- Study of the parameters influencing the choice of sustainability of public infrastructure (Polytechnique Montreal)
- Rethinking the role of the engineer in a degrowth society (Cargonomia - Hungary)

SECTORS OF ACTIVITY

- Industrial, commercial and service company; Eco-industry
- Consulting and technical design office; Research and innovation centre
- Business group or association; Economic development agency
- Local authority; Hospital
- Repair workshop; Resource centre; Recycling centre; Activities in the reuse or recycling of materials and construction waste
- Project management; Construction and waste recovery; Waste disposal, collection and treatment
- Environmental protection associations; NGO
- Alternative economy

CAREER PROSPECTS

- Eco-design engineer
- Local planning coordinator
- Strategy Manager
- Responsible buyer (public and private)
- Company director
- Architect and environmental engineer
- Consultant
- Low-tech and degrowth engineer

TEACHING STAFF

HEAD OF OPTION
Jean-Marc Benguigui

CENTRALE NANTES LECTURERS
Bertrand Huneau, Emmanuel Rozière

EXTERNAL SPEAKERS
University of Nantes, Nantes Métropole, Pays de la Loire Region
Véolia, Séché Groupe, Armor, WigWam, Toovalu, UpCyclea, EY France
Envie, Relais 44, La Ressourcerie, Solilab

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3RD YEAR PROFESSIONAL OPTION

ENGINEERING & DIGITAL SCIENCES FOR ART, CULTURE & HERITAGE

Discover how Human Sciences and Engineering Sciences come together: through methods, tools and languages.
Discover the worlds of art and entertainment, history, heritage and archaeology all from an engineering perspective.
A real change of focus in the engineering curriculum.

SKILLS DEVELOPED

- Acquire a common professional framework in the field of digital culture (tools, method, epistemology...)
- Develop key skills in the Centrale Nantes skills reference framework: ‘Business and innovation’ and ‘design and implementation of transdisciplinary projects’.

CAREER PROSPECTS

- Cultural institutions: museums, theatres
- Research laboratories
- Production or engineering companies
- Private companies specializing in media or heritage

HEAD OF OPTION
Florent Laroche

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GROUPE CENTRALE
This option aims to provide you with the methodological and behavioural framework to enable you to build your leadership skills and evolve towards a management position. Key course objectives:

- Understand management concepts and today’s issues
- Understand how organizations work and how they evolve
- Understand the foundations of individual and group behaviour
- Learn to communicate effectively both orally and in writing

COURSE CONTENT

- Management benchmarks and tools, business strategy, collective intelligence, design thinking, lean management
- Risk management
- Communication
- Inter-culturality in management
- Group work and behaviour
- Decision process

EXAMPLES OF PAST INTERNSHIPS

- Power, authority and leadership
- Business law

- Project management
- Consulting Engineer
- Implementation of quality procedures

HEAD OF OPTION

Catherine Michel

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The Research and Development professional option is designed for final-year engineering students who are keen to discover how academic and private research and its various professions work, from upstream research to advanced R&D work.

**COURSE CONTENT**

**INDUSTRIAL PROPERTY AND INNOVATION**
- Aims to raise student awareness of industrial property issues, the innovation process and project management: how does the idea of a technological innovation emerge and how can its development be financed, how to protect it, transform it into a product and get it into the market?

**RESEARCH METHODOLOGY, OVERVIEW OF PUBLIC AND PRIVATE R&D CAREERS**
- Offers an introduction to research methodology (bibliographical research, scientific ethics, dissemination). An overview of the different professions - in both industry and academia - related to R&D activities is provided.

**RESEARCH AND DEVELOPMENT PROJECT**
- The project is supervised by a member of a Centrale Nantes laboratory and generally involves other academic or industrial partners. Project topics are generally proposed by the members of the laboratories, in support of their research activity, but can also be defined on the students’ initiative.
EXAMPLES OF PAST PROJECTS

> Determination and identification of a behaviour law for a polymer material
> Additive manufacturing for climbing
> Validation of a behaviour model for thermoplastic materials
> Simulation in an atmospheric wind tunnel of dispersion in an urban canopy: concentration measurement by optical technique
> Design of a Flettner rotor to demonstrate offshore wind energy recovery by a hydro-wind vessel
> Optimization of the anchoring system for a floating wind turbine
> Analysis of radio emission spectra for the study of the interstellar medium
> Design of a robotic system for otologic surgery
> Search for attractors in the study of discrete dynamic systems
> Recognition of objects in an urban video using neural networks

EXAMPLES OF PAST INTERNSHIPS

> Similarity algorithm for 3D scans of megalithic rock art (University College Dublin)
> Multiscan registration for surface defect detection on aerospace components (McGill University, Montreal)
> Existence and uniqueness of linear and non-linear evolution equations (Universidad Cardenal Herrera, Valencia)
> Numerical simulation of the ventilation inception on surface-piercing hydrofoils (LHEEA, Centrale Nantes)
> Development of a wave-powered marine desalination system (Oneka, Port St Lucie, Florida)
> Microstructure modeling of cast iron (SINTEF Industry, Oslo)
> Metocean study and extreme value analysis of PTO extension in a wave energy converter (Carnegie Clean Energy, Perth)
> Software development for an augmented reality system (Thales, St-Héand)
> Modeling of pipelines in composite materials (Bureau Veritas, Paris)
> Fluid and thermal study of an innovative cooling system for an electrical module (Faurecia, Montbéliard)
> Development of a modelling and simulation tool for heating networks (CFERM Engineering, Paris)

CAREER PROSPECTS

> PhD thesis
> Researcher in academia
> Research Engineer
> R&D Project Manager
> R&D Consultant
> Business creator (start-up)

TEACHING STAFF

HEAD OF OPTION
Sébastien Bourguignon

LECTURERS
Sébastien Bourguignon, Ina Taralova

EXTERNAL SPEAKERS
INPI (Institut National de la Propriété Industrielle), Distingo conseil, EDF, IRT Jules Verne, CNES, Keosys, Dilepix

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The Science and Music option focuses on a specific sector, namely music, covering the main aspects from a scientific perspective: how musical instruments work, recording and distributing music, managing music databases and new methods of broadcasting and recommending music.

The option offers students who are highly motivated by music (e.g. accomplished players of a musical instrument), and intending to pursue an engineering career in this sector, the opportunity to acquire the necessary skills. Whilst there is no set requirement as to prior musical training or performance (musical instrument, composition, sound techniques), strong motivation and an open mind are essential.

**COURSE CONTENT**

- **Acoustics - Signal - Perception:** Basics for musical signal processing – Introduction to psychoacoustics
- **Musical Acoustics:** How the main families of musical instruments work – Room acoustics – audio engineering – History of music.
- **Digital music:** MIR (Music Information Retrieval) - Indexation and compression of music - detection of musical genre - Recommendation systems (Big data)
- **Project:** Personal project (musical production, instrument making and design, sound synthesis, automatic musical composition etc.)
**CAREER PROSPECTS**

Opportunities exist across different sectors of activity within various structures (company, start-up, institution):

> Instrument design, production monitoring, innovation
> Equipping listening areas
> Sound-synthesising software - digital audio processing, music production
> Music and emotion - neurosciences
> Music Information Retrieval (MIR) (recommendation systems, transcription, categorisation)
> New supports for broadcasting music
> Research (master, PhD)

**EXAMPLES OF PREVIOUS PROJECTS**

> Sonification of alert sounds for cars, company PSA, Vélizy
> Sound characterization of the hall L – HeHo Design, Nantes
> Study of the effect of acoustic bridges on the perceived quality of trumpets – see ISMA 2019 Conference papers
> Sonification of the measurement of the human skin, CLARINS company, Pontoise, See SMART 2019 Conference papers
> Rapid prototyping for musical instruments (mouthpieces), ITEMM, Le Mans.
> Production of a song. Recording, mixing, mastering.
> Automatic generation of melodies with Markov chains

**CONFERENCES**

> «La facture instrumentale». Romain Viala, Ingénieur de Recherche à l’ITEMM (Institut Technologique Européen des Métiers de la Musique)
> «Le design sonore». Nicolas Misdariis, Equipe de recherche Perception et Design sonore de l’IRCAM (Institut de Recherche et de Coordination Acoustique Musique).
> «Musique et interaction». Diemo Schwarz, chercheur à l’IRCAM. Mini concert de présentation de la musique interactive et d’interfaces tangibles.
> «Une petite histoire de la modernité musicale au XXième siècle». François Xavier Feron, IRCAM.

**TEACHING STAFF**

**HEAD OF OPTION**
Jean-François Petiot

**LECTURERS**
Mathieu LAGRANGE (CR CNRS, LS2N), Tom SOUAILLE (LS2N)

**EXTERNAL SPEAKERS**
Xavier MEYNIAL (Activeaudio), Joel GILBERT, Frédéric ABLITZER (LAUM, Le Mans), Romain VIALA (ITEMMM, Le Mans), François Xavier FERON, Nicolas MISDARIIS, Diemo SCHWARZ (IRCAM, Paris), Pierre AUMONT (IFSTTAR Nantes).

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