ENSTA BRETAGNE

→ TRAINING PROGRAM

You will find all the information on our training programs in this leaflet. Each semester is composed of projects and lessons organized into Course Units (Unités d'Enseignements/ UE in French).
The first two semesters are common to all students, whereas the following semesters are different according to the options you choose to further your studies (9 possible choices).

Important note : The candidate's level of language should enable him or her to follow classes taught in French and English. A minimum level of B1 is recommended in both languages.

YEAR 1 (BAC+3)

SEPTEMBER TO DECEMBER	JANUARY	FEBRUARY TO JUNE
SEMESTER 1	INTERNSHIP (4 weeks)	SEMESTER 2

YEAR 2 (BAC+4)

SEPTEMBER TO DECEMBER	DECEMBER TO APRIL	FROM MAY
SEMESTER 3	SEMESTER 4	INTERNSHIP (4 to 5 months)

YEAR 3 (BAC+5)

SEPTEMBER TO FEBRUARY	FROM MARCH
SEMESTER 5	SEMESTER 6 = END OF STUDIES INTERNSHIP (5 to 6 months)

CORE CURRICULUM

Course units = CU

Semester 1	Semester 2
SYSTEMS MODELING	
Mathematics for Engineers	Probability and Statistics
Introduction to Programming	Informatics
Introduction to MATLAB	Partial Differential Equations and Wave Propagation
Analysis of Spatial Data	Signal Processing 2
Signal Processing 1	Data Bases
Continuum Mechanics	Incompressible Fluid Mechanics
Energy and climate	
SCIENCES AND TECHNOLOGIES	
Technological Analysis	Manufacturing Processes
Computer Aided Design	Materials
Mechanics of Rigid Bodies	Mechanics of Deformable Bodies
Sensors and measurement systems	Experimental Mechanics
Automatics 1	Digital electronics (Arduino)
Introduction to Digital Systems	Sensor-Actuator Loop
	Electrotechnology
	Introduction to Systems Engineering
	ENGINEERING FOR TRANSITIONS
	Sustainable design
	Sustainable consumption and responsible innovation
	Tools for social and societal transitions

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5
HUMAN AND SOCIAL SCIENCES, SPORT AND LANGUAGE LEARNING				
LL1 English	LL1 English	LL1 English	LL1 English	Choice of LL1/LL2
LL2 optional	LL2 optional	LL2 optional	LL2 optional	Sport
Sport	Sport	Sport	Sport	Choice of Cultural Awareness Workshops
The Engineer and Society 1	The Engineer and Society 2	Financial analysis	Business games	Leadership week
Internship Preparation	Big Challenge		Optional Modules	
Personal Development 1	Personal Development		Research / Entrepreneurship projects	
Economics				
Bibliographic studies			Engineering and modeling	

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→ SPECIALIZATION

HYDROGRAPHY - OCEANOGRAPHY

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS FOR HYDROGRAPHY	**CU GEOMATICS**	**CU CARTOGRAPHY AND UNDERWATERNAVIGATION**
• Mathematics • Linear Optimization • Least Squares Method • Bathymetry	• Geographic Data Management • Estimation • Kalman filter	• Cartography • Law of the Sea • Underwater Navigation
UE GEOSCIENCES	**CU OCEANOGRAPHY AND MARINE GEOPHYSICS**	**CU REMOTE SENSING AND MODELING**
• Geology • Meteorology • Tides • Geodesy • Positioning Technology	• Descriptive Physical Oceanography • Marine Geophysics • Geophysical Fluid Dynamics • Sub-Bottom Profilers	• Remote Sensing • Coastal Ocean Modeling • Automatic seabed analysis
	CU HYDROGRAPHIC DATA PROCESSING AND ANALYSIS	**CU PROFILE**
	• Bathymetric Data Processing • Geostatistics / Spatial interpolation • Hydrographic Project Management	• Specific lessons according to profile • Sedimentary hydrodynamics • ADCP: Acoustic Doppler Current Profiler

OBSERVATION SYSTEMS AND ARTIFICIAL INTELLIGENCE

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS	**CU AI & DECISION SUPPORT**	**CU ARTIFICIAL INTELLIGENCE**
• Mathematics • Linear Optimization • Operational Research • Advanced imperative programming • Advanced object-oriented programming	• Decision and estimation theory • Digital optimization and Markov ModelsMachine • Machine learning	• Deep learning • Big data & data sciences • Quantum computing • Image and video
CU INFORMATICS AND NETWORKS	**CU INFORMATION PROCESSING**	**CU AUTONOMOUS SYSTEMS**
• Localization by Kalman Filtering • Waves and Environment • Waveform and Modulation	• Software Design • Estimation and regularization • Channel access electronics • Signal and Image Processing	• Visual Servoing • Microwave devices • AI & Embedded Systems • Antennas and transmit/receive chains
		CU OBSERVATION SYSTEMS
		• Remote Sensing • EM & GE Detection • Radar and Imaging

AUTONOMOUS ROBOTICS

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS	**CU INFORMATICS & ROBOTICS**	**CU ARTIFICAL INTELLIGENCE**
• Mathematics • Linear Optimization • Operational Research • C++ Language	• Interval Computation • SWR • GNU / Embedded Linux • Digital image processing	• Machine learning • Embedded machine learning • Initiation to Research
UE LOCALIZATION	**CU EXPLORATION**	**CU AUTONOMY**
• Introduction to Robotics • Inertial units • Kalman Filtering • Networks and OSs for robotics	• Robotic Challenge • Guiding of mobile robots • Simulation	• Visual Servoing • Software development • Systems Engineering
		CU ROBOTICS AND INDUSTRY
		• 3D vision • Robotic Architecture • Industry

DESIGN OF COMPUTING SYSTEMS

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS	**CU SYSTEM SECURITY**	**CU INFORMATION PROCESSING AND SECURITY**
• Mathematics • Linear Optimization • Operational Research • Introduction to networks	• Information Processing and Protection • Component Security • Machine learning	• End-to-end security • Certification and reverse engineering • Security applied to embedded networks and architectures • Verification
CU LOCALIZATION	**CU SYSTEMS ARCHITECTURE**	**CU SYSTEMS MODELING**
• Imperative programming in C • Exploitation System (OS) • Object-oriented programming in Java • Computer architecture	• Web application development • Software design • Compilation	• Distributed architectures and virtualization • Systems Simulation • Advanced and embedded operating systems •Parallel programming and advanced embedded technologies
		CU SOFTWARE ENGINEERING AND MODELING
		• Software product line engineering • Software-system modeling and meta-modeling • Web application development • Validation

OFFSHORE AND NAVAL ARCHITECTURE

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS FOR MECHANICS	**CU CORE SUBJECTS**	**CU THEORY AND PRACTICE**
• Mathematics • Materials • Finite Elements	• Composites & nanocomposites • Plates and Beams • Vibrations	• Offshore and Naval Platforms • Ship design Loop
CU BASICS IN NAVAL ARCHITECTURE	**CU OFFSHORE AND NAVAL ARCHITECTURE**	**CU CORE SUBJECTS FOR OFFSHORE AND NAVAL ARCHITECTURE**
• Mechanical Engineering • Introduction to Resistance to headway • Ship Structures basics • Ship stability • Wing lift theory • Turbulence and boundary layer • CFD Case Studies	• Fundamental principle of dynamics and notion of added masses and inertia • Wave theory and integral methods • Case study: wing theory • Introduction to the Finite Volume Method • Geometric non-linearity • Turbulence	• Maneuverability • Resistance and propulsion • Seaworthiness • Naval Structure
		CU PROFILES
		• Ship Hydrodynamics, • Ship Structures, • Offshore infrastructure architecture

PYROTECHNIC SYSTEMS

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS FOR MECHANICS	**CU CORE SUBJECTS**	**CU PYROTECHNIC SYSTEMS**
• Mathematics • Materials • Finite Elements	• Composites & nanocomposites • Plates and Beams • Vibrations	• Interior ballistics • Solid propulsion • Pyrotechnic Safety
CU BASICS IN PYROTECHNIC ENGINEERING	**CU PYROTECHNIC SYSTEMS**	**CU SHOCKS AND DETONATIONS**
• Mechanical Engineering • Wing lift theory • Thermics/Thermodynamics • Turbulence and boundary layer • CFD Case Studies	• Compressible Flows • Propulsion	• Shocks • Life cycles • Modeling and analysis of problems related to rapid dynamics
		CU COMBUSTION
		• Combustion • Detonations

VEHICLE ARCHITECTURE

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS FOR MECHANICS	**CU CORE SUBJECTS**	**CU VEHICLE ARCHITECTURE**
• Mathematics • Materials • Finite Elements	• Composites & nanocomposites • Plates and Beams • Vibrations	• Vehicle Architecture • Systems Engineering • Design in an automotive environment
CU MECHANICAL ENGINEERING AND HEAT ENGINES	**VEHICLE ARCHITECTURE**	**CU POWERTRAINS**
• Mechanical Engineering • Power Transmission Systems • Thermics/Thermodynamics	• Vehicle Dynamics • Electric Vehicles • Thermal engines: basics	• Thermal engines • Hybridization and hydrogen • Electric vehicle architecture • Power Transmission
		CU MATERIALS AND STRUCTURES
		• Finite Elements and Non-Linearity • Thermodynamics and Behavior Laws • Fatigue

ADVANCED MODELING OF MATERIALS AND STRUCTURES

SEMESTER 3	SEMESTER 4	SEMESTER 5
CU CORE SUBJECTS FOR MECHANICS	**CU CORE SUBJECTS**	**CU ADVANCED MODELING OF MATERIALS**
• Mathematics • Materials • Finite Elements	• Composites & nanocomposites • Plates and Beams • Vibrations	• Elastomers and composite Materials • Multiscale behavior modeling • Fatigue and Experimental Techniques
CU MECHANICAL ENGINEERING AND HEAT ENGINES	**CU ADVANCED MODELING OF MATERIALS AND STRUCTURES**	**CU SPECIFIC APPLIED FORCES**
• Mechanical Engineering • Power Transmission Systems • Thermics/Thermodynamics	• Introduction to Advanced Modeling of Materials and Structures • Optimization	• Modeling and analysis of problems related to rapid dynamics • Stability and nonlinear mechanics
		CU MODELING OF MATERIALS AND STRUCTURES
		• Non-linear Finite Elements • Thermodynamics and Constitutive Equations

→ SPECIALIZATION

ENGINEERING AND BUSINESS SCIENCE

SEMESTER 3	SEMESTER 4	SEMESTER 5
These in-depth studies take place in Semester 5. They are proposed in addition to the courses given in Semesters 3 and 4 and in one of the 8 other in-depth study paths.		
		CU TECHNOLOGICAL ECOSYSTEMS, CONTROL AND STRATEGY
		• Technological ecosystems: economic, political and legal environments • Strategy, organization and management of project performance • Technological market studies and human resources management
		CU PROJECT MANAGEMENT AND BUSINESS ENGINEERING
		• Fundamentals of project management • Project deployment (Industry management) • Innovation management and business engineering
		CU ENTREPRENEURSHIP - PERFORMANCE MANAGEMENT
		• Business Development • Intrapreneurship and performance management OR • Entrepreneurship



→ THE PROJECTS

SEMESTER 1 / Bibliography

The bibliographic study is approached as a research exercise: reading then synthesis of the technical and scientific documents. The objectives are to learn how to gather information, work in a team, successfully complete work within pre-fixed deadlines and write a formatted bibliographic synthesis. The students show proof of initiative, curiosity and autonomy.

SEMESTER 2 / Systems Discovery and Analysis

Semester 2 is composed of 3 projects enabling the first courses to be put into practice.

These 3 projects (the "Informatics" Project, the "Big Challenge" Project and the "Systems Discovery" Project) enable the students to develop their abilities to problematize, comprehend complexity in various fields as well as put their knowledge into practice to answer the issues raised.

SEMESTER 3 / Field Application Project

This Course Unit is composed of project leadership (leading a project...) and project management (multi-cultural aspects, diversity...), systems engineering courses and a scientific and technical pre-project linked to the chosen training profile. It comprises the 3rd step in the series of projects which aims to increase autonomy and the active acquisition of knowledge throughout the training.

SEMESTRE 4 / The Enhanced Focus Project

This enables future engineers to deal with an industrial issue proposed by a business in the field of mechanics, information technologies, or hydrography. Grouped into small teams (2 to 5 students), the future engineers are required to apply a project management approach to satisfy the industrial objectives defined by the project initiator.

This major project enables the students to apply their scientific and technological knowledge, make contacts, establish the scope of the subject and the important technical choices to respect the deadlines. In some cases, their work concludes with the design of a demonstrator.

SEMESTER 5 / Enhanced Focus Systems Project

This enables students to work on concrete subjects comparable with those that they will meetcarry out in their future career.

In order to confront this real industrial issue, in relation with their in-depth study path, the student engineers are called upon to review and apply their knowledge as well as demonstrate their initiative. This is not an academic exercise with a single solution. Within their teams, the students have to envisage different scenarios and choose the answer that seems to them to be the most suitable for the objectives and constraints imposed, in the time allowed.

The courses and ECTS listed in this document are for information purposes only. They are liable to change in line with company expectations.
These developments are part of the continuous improvement plan. ENSTA Bretagne has received the ISO 9001 accreditation for all its activities.