COURSE CATALOGUE ANNEX
EXCHANGES @ ENSTA

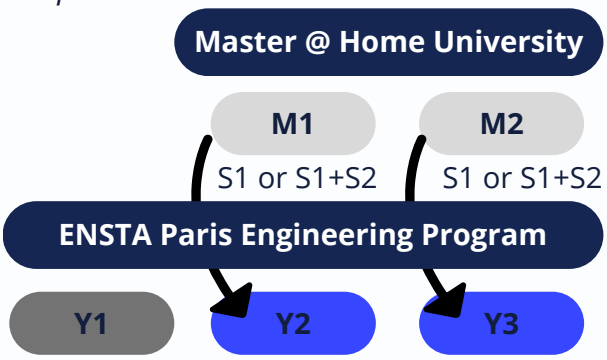
Exchange students nominated to ENSTA Paris-Saclay Campus by partner universities may study at ENSTA for one or two semesters depending on their program and study level. Exchange students can integrate either Year 2 or Year 3 directly at ENSTA at the Master's level or may choose to integrate an MSc program run by ENSTA through the Institut Polytechnique de Paris.

Reminders for Students on Exchange

- Students on exchange must take a minimum of 20/30-39 ECTS during exchanges and follow all courses that are mandatory in the curriculum.
- Exchange students must have a minimum of B2-level in English for all programs and a B1-level of French for courses taught in French.
- Students can not pick courses between multiple majors/minors/parcours. Students must pick one track for their entire exchange period.
- Courses at the Year 1-level at ENSTA are not open to exchange students.

Direct Exchange - ENSTA Engineering Program (Year 2 or Year 3)

Nominated exchange students can integrate the ENSTA Engineer program direclty for 1 or 2 semesters of exchange during their M1 or M2 year at their home university. Semester 2 alone is not possible.



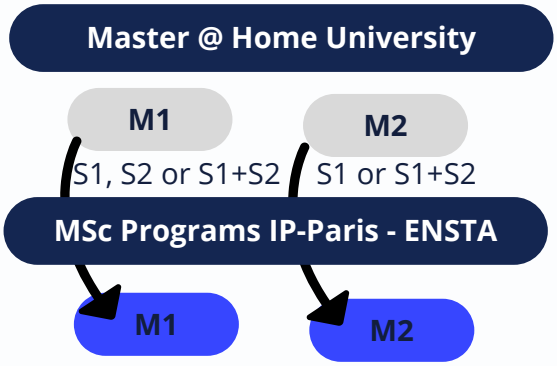
Y2 Majors (see pages 2-6)

- Mechanical Engineering
- Applied Mathematics
- Computer Science

Y3 Specializations (see pages 7-17)

- Mobility & Energy
- Mathematical Engineering
- Computer Science

MSc Progams Through Institut Polytechnique de Paris and ENSTA (M1 or M2)



IP Paris Masters (see pages 18-23)

Master Program	Level	Exchange Period		
		S1	S2	S1+S2
MSc Nuclear Energy	M1	✓	✓	✓
	M2	✓	NO	✓
MSc Science & Technology for Energy	M1	✓	✓	✓
	M2	✓	NO	✓
MSc Mechanical Engineering	M1	✓	✓	✓
	M2	✓	NO	✓
MSc Offwind - Offshore Wind Energy	M1	✓	✓	✓
	M2	M2 unavailable for exchange		

Course offerings subject to change.

YEAR 2 @ ENSTA DIRECT EXCHANGE

Major Mechanical Engineering (in French)

Semester 1 Courses:

Exchange must take all 17 ECTS of the mandatory bloc curriculum and at least 20 ECTS in total.

Mandatory Course Bloc 17 ECTS

APM_4ANN1_TA	The Finite Element (2 ECTS)
MEC_4FM01_TA	Compressible Fluid Flows (2 ECTS)
MEC_4MF03_TA	Turbulence (2 ECTS)
MEC_4TE04_TA	Climate Change (2 ECTS)
MEC_4MS01_TA	Non-Linear Behaviour of Materials (2 ECTS)
MEC_4MS02_TA	Modelling of Slendor Structure (2 ECTS)
MEC_4MS05_TA	Integrity & Fatigue of Structures (2 ECTS)
MEC_4MS04_TA	Waves & Vibrations in Mechanical Systems (2 ECTS)
FLE	French as a Foreign Language (1 ECTS)

Optional Cours Bloc 12 ECTS

ECO_4EA03_TA	Project Management (2 ECTS)
ECO_4EA06_TA	Industrial Economics & Innovation (2 ECTS)
HSS_4EA07_TA	Business & Commercial Law for Engineers (2 ECTS)
IME_4SYS1_TA	System Engineering (1 ECTS)
AN21xx	English (1.5 ECTS)
SPORT1	Sport (1 ECTS)
CL21x	Culture (1 ECTS) *culutre courses vary semester to semester*

Semester 2 Courses for Year Exchange Students:

Students must follow the 5.5 ECTS of the mandatory bloc curriculum and choose 1 minor, in which the student follows at least 6 courses for 7 ECTS. Students must take a minimum of 20 ECTS in total

Mandatory Course Bloc 5.5 ECTS

MDC_4MES1_TA	Modex Mechanical Experimental Module + Scientific Project (2.5 ECTS)
MEC_MS05_TA	Fluid-Structure Interactions (2 ECTS)
FLE	French as a Foreign Language (1 ECTS)

Optional Course Bloc 17 ECTS

PDV_40001_TA	Communication (2 ECTS)
AN22x	English (1.5 ECTS)
SPORT2	Sport (1 ECTS)
PIE	Team Engineer Project
HSS_4EA08_TA	Management : Company & Society (0.5 ECTS)
INT_4PRE1_TA	Research Internship (12 ECTS)

Minor: Smart Systems 7 ECTS (choice of 6 courses)

ECE_4ES06_TA	Electro-Mechanical Conversion (1.25 ECTS)
APM_4UT2_TA	Control of Dynamic Systems (1.25 ECTS)
MEC_4MS06_TA	Mechanical Conception & Numerical Analysis of Structures (1.25 ECTS)
CSC_4IN02_TA	Embedded and Object-Oriented Programming (1.25 ECTS)
ECE_4IC01_TA	Introduction to Networks (1.25 ECTS)
MEC_4MS11_TA	Life Cycle of a Material (1.25 ECTS)
MEC_4MS08_TA	Active Materials (1.25 ECTS)
ECE_4ES07_TA	Embedded Systems Architecture & Components for Autonomous Systems (1.25 ECTS)
MEC_4MS09_TA	Marterials for the Engineer (1.25 ECTS)
MEC_4MF07_TA	Acoustics in Fluid Media (1.25 ECTS)
CSC_4M104_TA	Image Analysis & Indexing (1.25 ECTS)

YEAR 2 @ ENSTA DIRECT EXCHANGE

Major Mechanical Engineering (in French)

Semester 2 Courses for Year Exchange Students: Minor Options Continued

Minor: Sustainable Energy 7 ECTS (choice of 6 courses)

PHY_4CB01_TA	Molecular Physics & Microscopic Energies (1.25 ECTS)
PHY_4CB03_TA	Introduction to Process Engineering for Energy (1.25 ECTS)
ECE_4ES06_TA	Electro-Mechanical Conversion (1.25 ECTS)
MEC_4MF02_TA	Heat & Mass Transfers in Fluids (1.25 ECTS)
MEC_4MF08_TA	Acoustics in Fluid Media (1.25 ECTS)
PRJ_4MEX2_TA	Scientific Project (1.25 ECTS)
PHY_4CBO2_TA	Advanced Thermodynamics (1.25 ECTS)
MEC_4SM11_TA	Life Cycle of Material (1.25 ECTS)
MEC_4MS12_TA	Materials for Energy (1.25 ECTS)
MDC_4SE05_TA	Energy Economics (1.25 ECTS)

Minor: Mechanical Modelling 7 ECTS (choice of 6 courses)

MEC_4MS08_TA	Active Materials (1.25 ECTS)
MEC_4MF07_TA	Acoustics in Fluid Media (1.25 ECTS)
MEC_4MS07_TA	Fracture Mechanics (1.25 ECTS)
APM_4ANA2_TA	Spectral Theory of the Self-Adjoints Operators (2.5 ECTS)
PHY_4PA02_TA	Plasma Physics (1.25 ECTS)
PHY_4PA01_TA	Advanced Statistical Physics (1.25 ECTS)
MEC_4M206_TA	Mechanical Conception & Numerical Analysis of Structures (1.25 ECTS)
MEC_4MS12_TA	Material for Energy (1.25 ECTS)
MEC_4MS09_TA	Materials for the Engineer (1.25 ECTS)
MEC_4MF09_TA	Dynamic Systems: Stability, Bifurcation and Chaos (1.25 ECTS)
MEC_4MF08_TA	Aeroacoustics & Flow Propragation (1.25 ECTS)
MEC_4MF10_TA	Introduction to Lattice Boltzmann Methods (1.25 ECTS)
MEC_4MF06_TA	Introduction to Computational
MEC_4MF07-TA	Fluid Dynamics (1.25 ECTS)
MEC_4MF02_TA	Thermal Transfer & Industrial Applictions (1.25 ECTS)
CSC-4M104_TA	Image Analysis & Indexing (1.25 ECTS)

Major Computer Science Engineering (in French)

Semester 1 Courses:

Exchange must take all 17 ECTS of the mandatory bloc curriculum and at least 20 ECTS in total.

Mandatory Course Bloc 17 ECTS

APM_4MA01_TA	Estimation and Statistical Identification (2 ECTS)
CSC_4IN04_TA	Software Engineering and Object Orientated Programming (4 ECTS)
CSC_4IN06_TA	Databases (2 ECTS)
CSC_4MI01_TA	Machine Learning (2 ECTS)
CSC_4OS01_TA	Operating Systems (2 ECTS)
ECE_4IC02_TA	Information Theory (2 ECTS)
ECE_4IC03_TA	Computer Networks (2 ECTS)
FLE	French as a Foreign Language (1 ECTS)

Optional Cours Bloc 12 ECTS

ECO_4EA03_TA	Project Management (2 ECTS)
ECO_4EA06_TA	Industrial Economics & Innovation (2 ECTS)
HSS_4EA07_TA	Business & Commercial Law for Engineers (2 ECTS)
IME_4SYS1_TA	System Engineering (1 ECTS)
AN21xx	English (1.5 ECTS)
SPORT1	Sport (1 ECTS)
CL21x	Culture (1 ECTS) *culutre courses vary semester to semester*

YEAR 2 @ ENSTA
DIRECT EXCHANGE

Major Computer Science Engineering (in French)

Semester 2 Courses for Year Exchange Students:

Students must follow the 5.5 ECTS of the mandatory bloc curriculum and choose 1 minor, in which the student follows at least 6 courses for a minimum of 7 ECTS. Students must take a minimum of 20 ECTS in total.

Mandatory Course Bloc 5 ECTS)

CSC_4OS02_TA	Parallel & Distributed Systems (2 ECTS)
ECE_4ES01_TA	Microprocessors Architecture (2 ECTS)
FLE	French as a Foreign Language (1 ECTS)

Optional Course Bloc 17 ECTS

PDV_40001_TA	Communication (2 ECTS)
AN22x	English (1.5 ECTS)
SPORT2	Sport (1 ECTS)
PIE	Team Engineer Project
HSS_4EA08_TA	Management : Company & Society (0.5 ECTS)
INT_4PRE1_TA	Research Internship (12 ECTS)

Minor: Artificial Intelligence & Cyberphysics 7 ECTS (choice of 6 courses)

APM_4RO02_TA	Applied Operational Research (1.25 ECTS)
APM_4AUT2_TA	Control of Dynamic Systems (1.25 ECTS)
ECE_4ES10_TA	New Generation Image Sensors (1.25 ECTS)
ECE_4IC12_TA	Internet of Things (1.5 ECTS)
CSC_4MI10_TA	Neuro-Computational Models of Vision (1.25 ECTS)
CSC_4MI06_TA	Computational Geometry & Mathematical Morphology (1.25 ECTS)
APM_4RO03_TA	Graphs, Games & Operational Research (2.5 ECTS)
CSC_4ROB1_TA	Introduction to Robotic Navigation (1.25 ECTS)
APM_4STA3_TA	Statistical Learning (1.25 ECTS)
APM_FMA03_TA	Discrete Mathematics for Information Protection (1.25 ECTS)*
CSC_4IN10_TA	Software Testing Techniques (1.25 ECTS)*
ECE_4ES06_TA	Electromechanical Conversion (1.25 ECTS)*

** Course selection must be validated by the DFR.*

Minor: Artificial Intelligence & Cyberphysics 7 ECTS (choice of 6 courses)

CSC_4IN10_TA	Software Testing Techniques (1.25 ECTS)
CSC_4IN11_TA	Web Development (1.25 ECTS)
CSC_4IN12_TA	Elements of Cybersecurity (1.25 ECTS)
APM_FMA03_TA	Discrete Mathematics for Information Protection (1.25 ECTS)
CSS_4IN13_TA	Principles of Programming Languages (2.5 ECTS)

YEAR 2 @ ENSTA
DIRECT EXCHANGE

Major Applied Mathematics Engineering (in French)

Semester 1 Courses:

Exchange must take all 17 ECTS of the mandatory bloc curriculum and at least 20 ECTS in total.

Mandatory Cours Bloc 17 ECTS

APM_4ANA1_TA	Functional Analysis (2 ECTS)
APM_4ANN1_TA	The Finite Element (2 ECTS)
APM_4OPT1_TA	Differentiable Optimisation 1 (2 ECTS)
APM_4PRB1_TA	Markov Chains (2 ECTS)
APM_4PRB2_TA	Discreet Time Martingales (2 ECTS)
APM_4RO01_TA	Introduction to Operations Research (2 ECTS)
APM_4SIM1_TA	Scientific Programming with C++ (2 ECTS)
APM84STA1_TA	Statistical Modelling (2 ECTS)
FLE	French as a Foreign Language (1 ECTS)

Optional Cours Bloc 12 ECTS

ECO_4EA03_TA	Project Management (2 ECTS)
ECO_4EA06_TA	Industrial Economics & Innovation (2 ECTS)
HSS_4EA07_TA	Business & Commercial Law for Engineers (2 ECTS)
IME_4SYS1_TA	System Engineering (1 ECTS)
AN21xx	English (1.5 ECTS)
SPORT1	Sport (1 ECTS)
CL21x	Culture (1 ECTS) *culutre courses vary semester to semester*

Semester 2 Courses for Year Exchange Students:

Students must follow the 5 ECTS of the mandatory bloc curriculum and choose 1 minor, in which the student follows at least 6 courses for 7 ECTS. Students must take a minimum of 20 ECTS in total

Mandatory Course Bloc 5 ECTS

APM_4AUT1_TA	System Control (2 ECTS)
APM_4SIM2_TA	Numerical Simulation (2 ECTS)
FLE	French as a Foreign Language (1 ECTS)

Optional Course Bloc 17 ECTS

PDV_40001_TA	Communication (2 ECTS)
AN22x	English (1.5 ECTS)
SPORT2	Sport (1 ECTS)
PIE	Team Engineer Project
HSS_4EA08_TA	Management : Company & Society (0.5 ECTS)
INT_4PRE1_TA	Research Internship (12 ECTS)

Minor: Engineering Mathematics (7 ECTS)

Choice of 2 Courses from:

APM_4ANA2_TA	Spectral Theory of the Self-Adjoints Operators (2.5 ECTS)
APM_4RO03_TA	Graphs, Games & Operational Research (2.5 ECTS)
APM_4STA3_TA	Statistical Learning (2.5 ECTS)
APM_4PRB4_TA	Mathematical Models for Finance (2.5 ECTS)
APM_4PRB7_TA	Stochastic Numerical Methods (2.5 ECTS)
APM_4STA4_TA	Statistical Numerical Methods (2.5 ECTS)
APM_4PRB6_TA+	High Perfomance Scientific
APM_4ANN3_TA	Calculation & Numerical Matrix Methods (2.5 ECTS)

Choice of 2 Courses from:

APM_4PRB3_TA	Introduction to Stochastic Calculus (1.25 ECTS)
CSC_4IN07_TA	Introduction to Databases (1.25 ECTS)
APM_4OPT2_TA	Advanced Differentiable Optimization (1.25 ECTS)
APM_4STA2_TA	Chronological Series (1.25 ECTS)
APM_4ANN2_TA	Analysis & Finite Element Approximation of PDEs (1.25 ETS)

YEAR 2 @ ENSTA DIRECT EXCHANGE

Major Applied Mathematics Engineering (in French)

Semester 2 Courses for Year Exchange Students: Minors Continued

Minor: Mecnahincal & Physical Models (7 ECTS)

Choice of 2 Courses from:

APM_4ANN2_TA Analysis & Finite Element Approximation of PDEs (1.25 ECTS)
APM_OPT2_TA Advanced Differentiable Optimization (1.25 ECTS)
APM_PRB3_TA Introduction to Stochastic Calculus (1.25 ECTS)
MEC_4MF06_TA Introduction to Computational Fluid Dynamics (1.5 ECTS)
MEC_4MS11_TA Life Cycle of a Material (1.25 ECTS)
MEC_4MS05_TA Structure Stability (1.25 ECTS)
PHY_4PA01_TA Advanced Statistical Physics (1.25 ECTS)
PHY_PA02_TA Plasma Physics (2.5 ECTS)
MEC_4MS07_TA Fracture Mechanics (2.5 ECTS)

Choice of 2 Courses from:

APM_4ANA2_TA Spectral Theory of the Self-Adjoints Operators (2.5 ECTS)
MEC_4MF08_TA+ MEC_F4M10_TA Acoustics in Fluid Media & Aeroacoustics & Flow Propagation + Introduction to Lattice Boltzmann Methods (5 ECTS)
MEC_4MF09_TA Dynamic Systems: Stability, Bifurcation & Chaos (2.5 ECTS)
APM_4SIM3_TA+ APM_4ANN3_TA Introduction to High Performance Computing + Advanced Numerical Matrix Models (5 ECTS)

YEAR 3 @ ENSTA DIRECT EXCHANGE

*Students can study directly at ENSTA during the 3rd year of studies during semester 1 only or for the full acadeic year (S1+S2). Please note that the **1st semester at ENSTA runs from September through the middle of April** and is worth 39 ECTS credits. Students must take a minimum of 20 ECTS during their exchange. Students must choose one specilization track and follow a selection of professional profile course during their exchange and can not pick courses between multiple tracks.*

Semester 1: Professional Profile Course Options (In French)

STEP ONE: Students choose 1 of 3 professionnal profiles in addition to their specilization track. Please note that not all professional profiles are available for each specialization track.

		Professional Profiles		
		Engineering & Design	Research & Innovation	Entrepreneurship & Intra-preneurship
Mobility & Energy Specizations	Smart, Sustainable Mobility & Vehicule Engineering	✓	✓	✓
	Sustainable Energy: Production & Optimization	✓	✓	✓
	Nuclear Power Engineering	✓	✓	✓
	Offshore Transport & Energy Structures	✓	✓	✓
Computer Science Specializations	Robotics & Smart, Autonomous Systems	✓	✓	✓
	Artificial Intelligence	✓	✓	✓
	Cybersecurity & Information System Architecture	✓	✓	✓
Applied Mathematics Specializations	Optimization & Data Sciences		✓	
	Modelisation & Simulation		✓	
	Quatitative Finance		✓	
	Mathematics for Health & the Environment		✓	

Engineering & Design

Professional Course Options

IME_5SINE_TA Industrial Strategy (1ECTS)
IMS_5ISYE_TA Engineering Systems Case Study (2 ECTS)
IME_5EA01_TA Project Management & Human Resources for Multicultural Teams (2 ECTS)
PRJ_5PROJ_TA Tutored Project (6 ECTS)

Research & Innovation

Professional Course Options

Students follow 11 ECTS of courses in one of the Master's programs through IP Paris at the M2 level.

Entrepreneurship & Intrapreneurship

Professional Course Options

KITE - Knowledge, Innovation, neTworks, Entrepreneurship (9 ECTS)
IME_5EA01_TA Project Management & Human Resources for Multicultural Teams (2 ECTS)

Optional Course Bloc

FLE French as a Foreign Language (1 ECTS)
AN21x English (1 ECTS)
PDV_5ENTS_TA Methods & Tools for Professional Insertion (1 ECTS)

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Specialization Tracks (In French)

Students must also choose 1 of 11 specialization track within their main field of study. This specialization track corresponds to 24 possible ECTS credits.

Mobility & Energy Specialization Tracks

Smart, Sustainable Mobility & Vehicle Engineering

Technology for Mobility Course Bloc

ECE_5MI04_TA	Multi-Sensor Systems for Autonomous Vehilcles (2 ECTS)
ECE_5MI05_TA	Hibridization & Electrification (2 ECTS)
ECE_5MI06_TA	New Modes of Propulsion (2 ECTS)

Mechanical Design Course Bloc

ECE_5MI04_TA	Numerical Modelling in Solid Mechanics (2 ECTS)
ECE_5MI05_TA	Computational Fluid Dynamics (2 ECTS)
ECE_5MI06_TA	Design & Modelling Project (2 ECTS)

Vector for Mobility Course Bloc

MEC_5MI10_TA	Automotive Engineering (2 ECTS)
MEC_5MI11_TA	Railway Engineering (2 ECTS)
MDC_5MI12_TA	Mobility Network Engineering (2 ECTS)

Complex Systems Course Bloc

MDC_5M107_TA	Complex Systems Engineering (2 ECTS)
MDC_5MI08_TA	MBSE and Multidisciplinary Multiphysics Optimization (MDO) (2 ECTS)
MDC_5MI09_TA	Intelligent & Autonomous Vehicles (2 ECTS)

Sustainable Energy: Production & Optimization

Energy Production Techniques Course Bloc

CHE_5EN01_TA	Fuels of Today & Tomorrow (3 ECTS)
MEC_5EN2A_TA	0 Carbon Energies - Nuclear Sector (1.5 ECTS)
MEC_5EN2B_TA	0 Carbon Energies - Renewable Secotrs (2 ECTS)
CHE_5EN03-TA	Combustion Energy Production (1.5 ECTS)
CHE_5EN04_TA	Energy Storage (2.5 ECTS)
PHY_5EN10_TA	Physics for Photovoltaics (1.5 ECTS)

Energy Core Curriculum Course Bloc

CCH_5EN40_TA	Policy & Prospectives for Energies (2 ECTS)

Tools for Energy Management Course Bloc

AMP_5EN5A_TA	Optimization (1.5 ECTS)
AMP_5EN5B_TA	Operational Research (1.5 ECTS)
AMP_5EN06_TA	Energy Optimization Project (1.5 ECTS)
CHE_5EN07_TA	Optimization of Energy Production Processes (2.5 ECTS)

Environment Course Bloc

CHE_5EN08_TA	Treatment of Effluents form Energy Industries (1.5 ECTS)
IME_5EN09_TA	Environmental Management (1.5 ECTS)

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Mobility & Energy Specialization Tracks Continued

Nuclear Power Engineering

Context Course Bloc

HSS_5NU01_TA	History of Nuclear Energy (0.5 ECTS)
CCH_5NU02_TA	Geopolitical and Defense Challenges (0.5 ECTS)
CCH_5NU03_TA	Context of Environmental and Enery Transition (1 ECTS)

Advanced Mechanics Course Bloc

MEC_5NU09_TA	Thermodynamics (2 ECTS)
MEC_5NU10_TA	Materials and Mechanics of Mechanics of Nuclear Materials (2.5 ECTS)
MEC_5NU11_TA	Digital for Nuclear Energy (1 ECTS)

Nuclear Energy of Today Course Bloc

MDC_5NU04_TA	Nuclear Center Operations (2.5 ECTS)
PHY_5NU05_TA	Physics of Reactors (3 ECTS)
CHE_5NU06_TA	Combustable Cycles (1.5 ECTS)
PHY_5NU07_TA	Nuclear Safety & Securtiy (1.5 ECTS)
PHY_5NU08_TA	Radiation Protection (1 ECTS)

Nucleau Energy in 2050 Course Bloc

MDC_5NU12_TA	Electric Systems (1 ECTS)
MDC_5NU13_TA	Dismantling & Waste Management (2 ECTS)
CCH_5NU13_TA	Reactors for the Future (2 ECTS)
MDC_5NU15_TA	*Naval Propulsion* (2 ECTS)*
MDC_5NU16_TA	*Non-Electrogenic Applications* (2 ECTS)*

*Choice of either courses

Naval Engineering

Hydromechanics Course Bloc

TCM301-I	Marine Hydronamics - Basics (2 ECTS)
MEC_5MA1A_TA	
TCM302	Stability & Seakeeping (2.5 ECTS)
MEC_5MA02_TA	

Structure Analysis & Modelling Course Bloc

TCM303	Numerical Modelling of Maritime Structures (3 ECTS)
MEC_5MA03_TA	
TCM304	Dimensioning, Resistance & Fatigue of Structures at Sea (2 ECTS)
MEC_5MA04_TA	

Students in this specialization track then choose between two options 'Transport' or 'Energy' and follow specific course blocs within the option. Students may not follow courses in multiple options.

Transport Option Courses

Ship Architecture & Propulsion Course Bloc

TCM301-II	Advanced Marine Hydronamics (2.5 ECTS)
MEC_5MA1B_TA	
TMA307	Naval Propulsion & Manoeuvrability (1.5 ECTS)
MEC_5MA07_TA	
TMA308	Power Generation & Naval Propulsion Plants (2 ECTS)
MEC_5MA08_TA	
TMA309	Computer-Aided Ship Design (2.5 ECTS)
MEC_5A09_TA	

System Engineering Course Bloc

TCM305	System Approach to Naval Engineering (6 ECTS)
MEC_5MA05_TA	

Continued on page 10

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Mobility & Energy Specialization Tracks Continued

Energy Option Courses

Energy Course Bloc

CCH_5EN40_TA	Policy & Prospective for Energies (2 ECTS)
EOS306	Offshore Oil & Gas (2 ECTS)
MEC_5EO02_TA	
EOS307_MEC_5EO03_TA	Marine Renewable Energies (2.5 ECTS)
EOS309	Sea State, Costal Waved &
MEC_5EO04_TA	Morphodynamics (2.5 ECTS)
EOS310	Coastal, Anchor and Cable
MEC_5EO05_TA	Engineering (2.5 ECTS)

System Engineering Course Bloc

EOS308	System Approach to
MEC_5EO01_TA	Windturbine Engineering (3 ECTS)

Semester 1: Computer Science Engineering Specialization Tracks

Robotics & Smart Autonomous Systems

System Engineering Course Bloc

CSC_5RO14_TA	Material and Software Architecture for Robots (3 ECTS)
CSC_5RO10_TA	Function Safety for Autonomouos Systems (2 ECTS)
CRC_5RO08_TA	System Engineering for Embedded Systems (2 ECTS)

Embedded Software Course Bloc

CSC_RO01_TA	Modelling & Automatic Code Generation (2 ECTS)
CSC_5RO05_TA	Mulitask Conception & Real Time OS (1.5 ECTS)

Embedded Systems Course Bloc

CSC_5RO06_TA	Hardward Accelerators for AI & Robotics (2 ECTS)
ECE_5RP07_TA	MPSOC Multiprocessors on Chip (2 ECTS)

Tools Course Bloc

CSC_5RO11_TA	Robot Learning (2 ECTS)
CSC_5R012_TA	Navigation for Autonomous Systems (1.5 ECTS)
CSC_5RO13_TA	Deep Learning Based Computer Vision (1.5 ECTS)
CSC_5RO16_TA	Planification & Control (1.5 ECTS)
CSC_5RO15_TA	Modelling and Commands of Robotic Manipulators (1.5 ECTS)
CSC_5RO17_TA	3D Vision (1.5 ECTS)

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Computer Science Engineering Specialization Tracks Continued

Artificial Intelligence

Knowledge & Reasoning Course Bloc

APM_5AI01_TA	Logical Knowledge & Reasoning (2 ECTS)
CSC_5IA02_TA	Constraint-Based Programming (2 ECTS)
APM_5AI04_TA	Probability Knowledge & Reasoning (2 ECTS)
APM_5AI29_TA	Language Models & Structured Data (2 ECTS)
CSC_5AI12_TA	Automatic Language Treatment (2 ECTS)
CSC_5IA13_TA	Predictive Maintenance (1.5 ECTS)

Learning Course Bloc

CSC_5IA05_TA	Learning for Robots (1.5 ECTS)
CSC_5AI06_TA	Deep Learning (2 ECTS)
APM_5AI18_TA	Reinforcement Learning (2 ECTS)
APM_5AI07_TA	GPU Programming for Learning (2 ECTS)
CSC_5IA23_TA	Deep-Learning Based
CSC_5IA21_TA	Computer Vision (2 ECTS) Project (2 ECTS)

Cybersecurity & Information System Architecture

Software Engineering Course Bloc

CSC_5CY01_TA	Software Platforms for Company Applications (1.5 ECTS)
CSC_5CY02_TA	Software Modelling (0.5 ECTS)
CSC_5CY03_TA	Database Management Systems (2 ECTS)
CSC_5CY04_TA	Agile Methodology (1.5 ECTS)
CSC_5CY05_TA	Advanced Processing & Scripting on Linux (1.5 ECTS)

Architecture Course Bloc

CSC_5CY06_TA	Information System Architecture (2 ECTS)
CSC_5CY07_TA	Big Data (2.5 ECTS)

Security Engineering Course Bloc

CSC_5CY08_TA	Cryptology Information Protection (2 ECTS)
CSC_5CY09_TA	Information Systems Security (2 ECTS)
CSC_5CY10_TA	Security Governance (2 ECTS)
CSC_5CY11_TA	Cybersecurity of Industrial Systems (1.5 ECTS)
CSC_5CY12_TA	Audit, Risk Analysis & Investigation (2 ECTS)
CSC_5CY13_TA	Analysis of Source and Binary Vulnerability (2 ECTS)
CSC_5CY14_TA	Cloud & Security (1.5 ECTS)

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Applied Mathematics Specialization Tracks

Optimization & Data Sciences

Students in this specialization track choose between 6 profile options and follow specific course blocs within the option. Students may not follow courses in multiple options.

For Students Following the Research & Innovation Profile - Optimization Option

Optimization Course Bloc

APM_5OD1A_TA	Optimal Control of Ordinary Differential Equations (ODEs) (2 ECTS)
APM_5OD2A_TA	Markov Decision Processes: Dynamic Programming & Applications (2 ECTS)
APM5OD21_TA	Discrete Optimization (2 ECTS)
APM_5OD22_TA	Operational Research and Data Sciences (2 ECTS)
APM_5OD23_TA	Complexity Theory (2 ECTS)

Advanced Optimization Course Bloc

APM_5OD1N_TA	Optimal Control II (3 ECTS)
APM_5OD2B_TA	Dynamic Programming II (3 ECTS)
M2-OPTIM-SO	Stochastic Optimization (4 ECTS)

Optimization & Data Sciences

Students in this specialization track choose between 6 profile options and follow specific course blocs within the option. Students may not follow courses in multiple options.

For Students Following the Research & Innovation Profile - Organization & Strategy Option

Optimization Course Bloc

APM_5OD1A_TA	Optimal Control of Ordinary Differential Equations (ODEs) (2 ECTS)
APM_5OD2A_TA	Markov Decision Processes: Dynamic Programming & Applications (2 ECTS)
APM5OD22_TA	Interger Optimization for Machine Learning (2 ECTS)
APM_5OD23_TA	Complexity Theory (2 ECTS)
APM_5OD24_TA	Meta-Heuristics (2 ECTS)

Data & Information Course Bloc

COSI-1	Digital Transformation (3 ECTS)
COSI-2	Information Systems (3 ECTS)
COSI-3	Data Analysis and Graph Theory Methods (3 ECTS)
COSI-4	Governance & Growth of Multinational Companies (3 ECTS)

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YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Applied Mathematics Specialization Tracks Continued

Optimization & Data Sciences

For Students Following the Research & Innovation Profile - Operational Research Option

Optimization Course Bloc

APM_5OD1A_TA	Optimal Control of Ordinary Differential Equations (ODEs) (2 ECTS)
APM_5OD2A_TA	Markov Decision Processes: Dynamic Programming & Applications (2 ECTS)
APM_5OD21_TA	Discrete Optimization (2 ECTS)
APM_5OD22_TA	Operational Research & Data Science (2 ECTS)
APM_5OD23_TA	Complexity Theory (2 ECTS)
4APM_5OD24_TA	Meta-Heuristics (2 ECTS)

Operational Research Course Bloc

PRO-DECO	PLNE Decomposition Methodes (3 ECTS)
MPRO-OI	Optimization in Uncertainty (3 ECTS)
MPRO-BOG	Optimization Basics for Graphs (3 ECTS)

Optimization & Data Sciences

For Students Following the Research & Innovation Profile - Data Science Option

Optimization Course Bloc

SOD312	Markov Decision Processes:
APM_5OD2A_TA	Dynamic Programming & Applications (2 ECTS)
SOD313	Optimization & Approximation
APM_5OD13_TA	Problems (2 ECTS)
SOD314	Cooperative Optimization for
APM_5OD14_TA	Data Science (2 ECTS)
SOD321	Discrete Optimization (2 ECTS)
APM_50D21_TA	
SOD322	Operational Research & Data
APM_5OD22_TA	Science (2 ECTS)

Learning Course Bloc

DS-1	Deep Learning I (2.5 ECTS)
DS-2	Statistical Learning Theory (2.5 ECTS)
DS-3	Reinforcement Learning (2.5 ECTS)
DS-4	Deep Learning II (2.5 ECTS)
DS-5	Data Camp (4 ECTS)

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YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Applied Mathematics Specialization Tracks Continued

Optimization & Data Sciences

For Students Following the Research & Innovation Profile - Math, Vision & Learning Option

Optimization Course Bloc

APM_5OD1A_TA	Optimal Control of Ordinary Differential Equations (ODEs) (2 ECTS)
APM_5OD2A_TA	Markov Decision Processes: Dynamic Programming & Applications (2 ECTS)
APM_5OD21_TA	Discrete Optimization (2 ECTS)
APM_5OD22_TA	Operational Research & Data Science (2 ECTS)
APM_5OD23_TA	Complexity Theory (2 ECTS)
APM_5OD24_TA	Meta-Heuristics (2 ECTS)

Mathematics, Learning & Vision Course Bloc

MVA-1	Computational Statistics (4 ECTS)
MVA-2	Object Recognition & Computer Vision (4 ECTS)
MVA-3	Deep Learning (4 ECTS)

Optimization & Data Sciences

For Students Following the Research & Innovation Profile - Operational Research Option

Optimization Course Bloc

APM_5OD1A_TA	Optimal Control of Ordinary Differential Equations (ODEs) (2 ECTS)
APM_5OD2A_TA	Markov Decision Processes: Dynamic Programming & Applications (2 ECTS)
APM_5OD21_TA	Discrete Optimization (2 ECTS)
APM_5OD22_TA	Operational Research & Data Science (2 ECTS)
APM_5OD23_TA	Complexity Theory (2 ECTS)
APM_5OD24_TA	Meta-Heuristics (2 ECTS)

Optimization Course Bloc Continued

APM_5OD14_TA	Cooperative Optimization for Data Science (2 ECTS)
APM_5OD31_TA	Automatic Identification (2 ECTS)
APM_5OD32_TA	Geometric Control (2 ECTS)
APM_5OD33_TA	Optimal Bayesian Filtering and Particle Approximation (2 ECTS)
APM_5OD34_TA	Non-Linear Chronological Series (2 ECTS)

Specializations in Applied Mathematics continued on page 15.

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Applied Mathematics Specialization Tracks Continued

Modelling & Simulation

Common Course Bloc

APM_5MS01_TA	Parallel Scientific Calculations (3 ECTS)
APM_5MS03_TA	Variational Methods for the Analysis & Resolution of Non-Coercive Problems (3 ECTS)
APM_5MSX1_TA	Periodical Homogenization (3 ECTS)
APM_5MS05_TA	Inverse Problems for EPD-Run Systems (3 ECTS)
APM_5MS07_TA	Diffraction Problems in Unbounded Domains (3 ECTS)

Students in this specialization track must choose 1 out of 4 sub-specialization tracks. Students can only follow courses in that chosen sub-specialization and cannot mix and match.

Calculation & Simulation

Course Bloc

APM_5MSI3_TA	Hybrid & Multi-Core Programming (3 ECTS)
APM_5MSX2_TA	Advanced Numerical Models & High Performance Calculation (3 ECTS)
APM_5MS04_TA	Integral Neural Network Equations: Numerical Methods & Advanced Algorithms (3 ECTS)

Analysis & Simulation

Course Bloc

APM_5MS06_TA	Advanced Discretion Techniques for Evolution Problems (3 ECTS)
APM_5MS08_TA	Mathematical Models & their Discretization in Electromagnetism (3 ECTS)
APM_5MS10_TA	Integral Equations & Delayed Potentials (3 ECTS)

Physics Modelling

Course Bloc

APM_5MS09_TA	Plasma & Astrophysics Modelling (3 ECTS)
APM_5MSI1_TA	Modeling & Simulation of Fluid Flows in Geosciences (3 ECTS)
APM_5MSI3_TA	Hybrid and Multi-Core Programming (3 ECTS)

Mathematics for Life

Course Bloc

APM_5MSE2_TA	Introduction to Medical Imaging (3 ECTS)
APM_5MS04_TA	Integral Neural Network Equations: Numerical Methods & Advanced Algorithms (3 ECTS)
APM_5MS06_TA	Advanced Discretion Techniques for Evolution Problems (3 ECTS)

Specializations in Applied Mathematics continued on page 16.

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Applied Mathematics Specialization Tracks Continued

Quantitative Finance

Common Core Course Bloc

APM_5FQ01_TA	Numerical Methods for Partial Derivative Equations (PDEs) (2 ECTS)
APM_5FQ02_TA	Levy Processus and Applications in Finance (2 ECTS)
APM_5FQ04_TA	Valuation of Derivatives with Multiple Yield Curves, Financing Cost Adjustment, Credit Cost Adjustment (2 ECTS)
APM_5FQ05_TA	Credit Risk (2 ECTS)

Common Core Course Bloc

FA351	Green Finance (2 ECTS)
APM_5FQ06_TA	Electricity Markets (2 ECTS)
APM_5FQ07_TA	Elements of Stochastic Calculus (2.5 ECTS)
APM_5OD33_TA	Optimal Baysian Filtering & Particular Approximation (2 ECTS)
MS305	Pricing & Hedging of Financial Derivatives (3.5 ECTS)

Students in this specialization track must choose 1 out of 3 sub-specialization tracks. Students can only follow courses in that chosen sub-specialization and cannot mix and match.

Finance Option

Core Course Bloc

APM_F5Q08_TAA	Advanced Stochastic Calculus (2 ECTS)
PM_5FI11_AE	Foundations of Risk Management (2 ECTS)

Statistics Option

Core Course Bloc

APM_F5Q08_TA	Advanced Stochastic Calculus (2 ECTS)
APM_53674_EP	Advanced Machine Learning (2 ECTS)

ENSAE Option

Core Course Bloc

FA304	Interest Rate Curve Models (2 ECTS)
FA328	Fondations of Risk Management (2 ECTS)

Specializations in Applied Mathematics continued on page 17.

YEAR 3 @ ENSTA DIRECT EXCHANGE

Semester 1: Applied Mathematics Specialization Tracks Continued

Mathematics for Health and the Environment

Stochasic & Statistics Course Bloc

APM_5FQ07_TA	Elements of Stochastic Calculus (3 ECTS)
APM_5MSE1_TA	Maching Learning (3 ECTS)

Optimization & Control Course Bloc

SOD311	Optimal Control Theory of Ordinary Differential Equations (1&2) (5 ECTS)
SOD313	Optimization & Approximation Problems (2 ECTS)

Life Course Bloc

APM_5MSE2_TA	Introduction to Medical Imagery (3 ECTS)
APM_5MSE3_TA	Mathematical Modelisation & Estimation in Cardiatric Biomechanics -Theories & Medical Applications (2 ECTS)

Modelling & Simulation Course Bloc

AMS301	Parallel Scientific Calculations (3 ECTS)
APM_5MS01_TA	
AMS305	Inverse Problems for EDP-Governed Systems (3 ECTS)
APM_5MS05_TA	

Semester 2 : All Tracks (Only available for students who also followed S1)

Master's Thesis & Internship (PFE)

- Internship starting at the middle of April for 5 months minimum (21 ECTS)

M1 & M2 EXCHANGE @ ENSTA THROUGH IP-PARIS

Students can integrate select Institut Polytechnique de Paris Master programs which are run through ENSTA (please note that courses will often be at different campuses than ENSTA). At the Master 1 level, depending on the program, students can participate in the exchange of one semester only (either S1 or S2) or for the full academic year. At the Master 2 level, depending on the program, students can participate in the exchange for one semester (S1 only), or for the full academic year.

		Exchange Period		
Master Program	**Level**	**S1**	**S2**	**S1+S2**
MSc Nuclear Energy	**M1**	✓	✓	✓
	M2	✓	NO	✓
MSc Science & Technology for Energy	**M1**	✓	✓	✓
	M2	✓	NO	✓
MSc Mechanical Engineering	**M1**	✓	✓	✓
	M2	✓	NO	✓
MSc Offwind - Offshore Wind Energy	**M1**	✓	✓	✓
	M2	M2 unavailable for exchange		

MSc Nuclear Energy (in English)

M1 Semester 1 Courses:

Core Course Bloc

PHY_4CNUC_TN Basic Nuclear Physics (4 ECTS)
PHY_4CTHE_FR Thermodynamics (3 ECTS)
PHY_4CRAD_TN Interactions of Radiation with Matter (3 ECTS)
PHY_4CNEU_TN Basic Neutronics (2 ECTS)
MEC_4CENE_TA Energy Production Technologies (2 ECTS)
APM_4CMAT_FR Mathematics (3 ECTS)

Physics & Engineering Course Bloc

ECE_4PELE_CS Electrical Power Engineering (3 ECTS)
MEC_4PMAT_TA Material Science & Mechanics (4 ECTS)
PHY_4PQUA_FR Basic Quantum Mechanics (3 ECTS)

Chemistry & Engineering Course Bloc

CHE_4XSOL_FR Solution Chemistry I - Speciation & Process (4 ECTS)
CHE_4XMAT_FR Chemistry of Nuclear Materials (4 ECTS)
PHY_4XRAD_FR Atomic & Molecular Spectroscopy (3 ECTS)
PHY_4XRAD_FR Radiolysis (2 ECTS)

Optional Course Bloc

MDC_4CLAN_FR French as a Foreign Language (2 ECTS)

M1 Semester 2 Courses:

Core Course Bloc

ECO_4CECO_CS Economics of Energy (3 ECTS)
PRJ_4CPRO_FR Project Management (3 ECTS)
CHE_4CCHE_TA Chemical Engineering (3 ECTS)
CSC_4CDAT_FR Data Processing (3 ECTS)

Chemistry & Engineering Course Bloc

PHY_4XRAD_FR Atomic & Molecular Spectroscopy (3 ECTS)
PHY_4CANC_FR Analytical Chemistry of Radioactive Elements (4 ECTS)
CHE_4XCHE_TN Solution Chemistry 2 - Separation (3 ECTS)

M1 & M2 EXCHANGE @ ENSTA THROUGH IP-PARIS

MSc Nuclear Energy Continued

M1 Semester 2 Courses Continued:

Physics & Engineering Course Bloc

ECE_4PCON_CS	Control & Command (3 ECTS)
MEC_4PFLU_CS	Fluid Mechanics & Heat Transfer (4 ECTS)
MEC_4PMEC_TA	Continuum Mechanics (1 ECTS)
PHY_4PDET_FR	Detection Applied to Physics (2 ECTS)

Optional Course Bloc

Internship (9 ECTS)

M2 Semester 1 Courses:

Reactor Physics Course Bloc

MDC_5CENE_TN	FPWR System & Operations (3 ECTS)
MDC_5CRP_TN	Radioprotection (3 ECTS)
MDC_5CSAF_TN	Introduction to Security (3 ECTS)
PHY_5CSYS_TN	Nuclear Fuel Cycles: Nuclear Reactor Systems (3 ECTS)
CSC_5DCOD_TA	Conception, Calculs & Control Part 1 (3 ECTS)
MEC_5DCON_TA	Material Physics: Concerte (1 ECTS)
PHY_5CDON_TN	Nuclear Physics & Neutronics (3 ECTS)
PHY_5CFLUI_TN	Thermohydraulics (2 ECTS)
MEC_5DSEI_TA	From Seismology to Earthquake Engineering (2 ECTS)
CHE_5FCMS_FR	Cooling & Molten Salt (? ECTS)
CSC_5FCOD_CP	Process Simulation & Control (3 ECTS)
CHE_5FDIS_CP	Waste Disposal (? ECTS)
CHE_5FFUE_CP	Fuel: From Mine to the Reactor (? ECTS)

Reactor Physics Course Bloc Continued

PHY_5RMAT_TN	Nuclear Materials (2 ECTS)
PHY_RNEU_TN	Neutronics 1 (3 ECTS)
PHY_5RNUC_FR	Nuclear Physics (4 ECTS)
CHE_5FSEP_CP	Separation & Recycling (4 ECTS)
CHE_5FFUE_CP	Fuel: From Mine to the Reactor (3 ECTS)
MDC_5CRIS_CS	Risk Management (4 ECTS)
PHY_5CFWN_FR	Introduction to Nuclear Physics, Neutronics (3 ECTS)
CHE_5FWAS_CP	Waste Containment Materials (3 ECTS)
MDC_5ODEC_CS	Informed Decision Making (4 ECTS)

Reactor Physics & Simulation Course Bloc

MDC_5WDEC_PP	Methods of Decommissioning (3 ECTS)
MDC_5WDIS_PP	Dismantling & Decommissionning Nuclear Facilities (3 ECTS)
MDC _5WWA1_CS	Waste Management Part 1 (2 ECTS)

M2 Semester 2 Courses:

Reactor Physics & Simulation Course Bloc

MDC_5CTRA_TN	Energy Transition & Flexibility (2 ECTS)
CHE_5DCOR_TA	Physics of Materials: Corrosion (1 ECTS)
MDC_5DDES_TA	Conception (2 ECTS)

Reactor Physics & Simulation Course Bloc Continued

MDC_5DSYS_TA	Systems & Equipment Maintenance (4 ECTS)
MDC_5OOPE_CS	Operation Management (3 ECTS)
MEC_5DNUM_TA	Numerical Conception (3 ECTS)

M1 & M2 EXCHANGE @ ENSTA THROUGH IP-PARIS

MSc Nuclear Energy Continued

M2 Semester 2 Courses Continued:

Reactor Piloting Course Bloc

MDC_5OSAF_CS	Safety & Production (4 ECTS)
PHY_5RFLU_TN	Advanced Thermal Hydraulics (3 ECTS)
PHY_5RMPH_TN	Multiphysics & Uncertainties (1 ECTS)
PHY_5RNEU_TN	Neutronics 2 (3 ECTS)
CSC_5WCOD_CS	Calculation Codes (2 ECTS)
MDC_5WWA2_CS	Waste Management (3 ECTS)
S4-O-NDT	Non Destructive Testing (1.5 ECTS)

Master's Thesis

Internship (20 weeks minimum) (18 ECTS)

MSc Sciences & Technology for Energy (in English)

M1 Semester 1 Courses:

Core Course Bloc (Choice of 4/5 Courses):

PHY_51055_EP	Energy & Environment (5 ECTS)
MEC_51059_EP	Mechanics for Wind Energy (5 ECTS)
PHY_51004_EP	Physics & Engineering of Photovoltaic Devices (5 ECTS)
PHY_51005_EP	Power Electrical Engineering for Renewable Energy (5 ECTS)
MEC_51455_EP	Greenhouse Gases: Challenges & Observation (5 ECTS)

Elective Course Bloc (Choice of 2/3 Courses:

MEC_51058_EP	Continental Hydrology & Water Resssources (5 ECTS)
MEC_51055_EP	Instabilities & Turbulence (5 ECTS)
IME_51459_EP	Energy Industry Value Chain (5 ECTS)

Optional Course Bloc:

LFR_50101_EP	French as a Foreign Language* (1 ECTS)

M1 Semester 2 Courses:

Core Course Bloc (Choice of 4/6 Courses):

MEC_52061_EP	Fluid-Structure Interactions (5 ECTS)
MEC_52065_EP	Meteorology & Environment (5 ECTS)
PHY_52063_EP	Material Science for Energy Conversion & Storage (5 ECTS)
PHY_4CB01_TA	Microscopic Energetics (5 ECTS)
PHY_4CB02_TA	Advanced Thermodynamics (5 ECTS)
PHY_4CB03_TA	Introduction to Process Stimulation (5 ECTS)

Elective Course Bloc:

MEC_4MS12_TA	Materials for Energy (3 ECTS)
MEC_4MS13_TA	Energetic Materials* (3 ECTS)
MDC_4EA05_TA	Energy Economics* (3 ECTS)
MEC_52468_EP	Geological Storage of Energy & Waste (5 ECTS)
IME_52065_EP	Managing Sustainable Innovation (5 ECTS)
IME_52469_EP	Sustainable Strategy & Business Models (5 ECTS)

* Courses offered in French

M1 & M2 EXCHANGE @ ENSTA THROUGH IP-PARIS

MSc Sciences & Technology for Energy (in English) Continued

M2 Semester 1 Courses:

Core Course Bloc (Choice of 16 ECTS):

BIO_53453_EP	Nature-Based Solutions to Substitute Fossil Fuels (4 ECTS)
CHE_53461_EP	Chemical Storage of Energy (4 ECTS)
MEC_53455_EP	Introduction to Atmopsheric Composition (4 ECTS)
MEC_51455_EP	Greenhouse Gases: Challenges & Observation (4ECTS)
PHY_53452_EP	Organic-Based Materials of the 3rd Gen Solar Cells (4 ECTS)
PHY_51006_EP	Building & Using Models for Energy Transition (4 ECTS)
APM_5EN5A_TA	Continuous Optimization (2 ECTS)
APM_5EN5B_TA	Discrete Optimization (2 ECTS)

Elective Course Bloc (Choice of 16 ECTS):

IME_53469_EP	Designing Projets & Managing Operations (4 ECTS)
CHE_5EN01_TA	Fuels for Today & Tomorrow (4 ECTS)
MEC_5EN2B_TA	Low Carbon Energies: Renewables (2 ECTS)
CHE_5EN04_TA	Energy Stockage* (4 ECTS)

M2 Semester 2 Courses:

Core Course Bloc (Choice of 14 ECTS):

PHY_54461_EP	Thermal Renewable Energies (4 ECTS)
MEC_52462_EP	Hydro, wind & Marine Ressources (4 ECTS)
MEC_54466_EP	Climate Change & Energy Transition (4 ECTS)
PHY_54401_EP	Thin Film Photovoltaics (4 ECTS)
PHY_54402_EP	PV Technologies in Industry (4 ECTS)
ECE_54401_EP	Smart Grid for Renewable Energy (4 ECTS)
MEC_54462_EP	Wind Power (4 ECTS)
APM_5EN06_TA	Optimization Projects in the Energy Sector (2 ECTS)
CHE_5EN07_TA	Simulation & Optimization of Energy Production Processes (4 ECTS)

Elective Course Bloc:

CHE_5EN03_TA	Combustion & Energy Production* (2 ECTS)
CHE_5EN08_TA	Treatment of Effluents from the Energy Industry (2 ECTS)
PHY_5EN10_TA	Physics for Photovoltaics (2 ECTS)
MEC_51059_EP	Mechanics for Wind Turbines (2 ECTS)
MEC_54467_EP	CO2 Emissions Reduction (4 ECTS)
MEC_5EO04_TA	Sea State, Wave Propagation & Ocean Wave Energy (4 ECTS)
CSC_5RO08_TA	System Engineering (3 ECTS)

Master's Thesis & Internship

Internship (6 months minimum) (22 ECTS)

* Courses offered in French

M1 & M2 EXCHANGE @ ENSTA THROUGH IP-PARIS

MSC Mechanical Engineering (in English)

M1 Semester 1 Courses:

Core Course Bloc:

MEC_51060_EP	Solid Mechanics (3 ECTS)
MEC_4MMI3_TA	Fundamental Concepts in Fluid Mechanics (5 ECTS)
MEC_51053_EP	Numerical Methods in Solid Mechanics (3 ECTS)
MEC_4MMI1_TA	Introduction to 3D Continuum Mechanics (3 ECTS)
MEC_51056_EP	Dynamics of Solids and Structures (3 ECTS)

Economics Course Bloc (Choice of 1 Course):

ECO_52181_EP	Economics of Biodiversity (3 ECTS)
ECO_52185_EP	Economics Facing Nature: History & Context (3 ECTS)
ECO_52064_EP	Economics of Energy Sectors (3 ECTS)
ECO_5EA18_TA	Economics of Mobility (3 ECTS)
ECO_5EA19_TA	Economics of Digital Technology (3 ECTS)

Elective Course Bloc (Choice of 8 ECTS):

MEC_51051_EP	Materials Behavior: Plasticity & Fracture (3 ECTS)
MEC_52062_EP	Mecahnis & Multiphysics Couplings (3 ECTS)
MEC_43033_EP	Dynamics of the Atmosphere & Ocean (3 ECTS)
MEC_4MFO7_TA	Acoustics in Fluid Media (3 ECTS)
MEC_4MS05_TA	Fluid-Structure Interactions (3 ECTS)

Optional Course Bloc:

MEC_53655_EP	Personal Reserach Project
FLE	French as a Foreign Language

M1 Semester 2 Courses:

Core Course Bloc:

MEC_4MMI2_TA	Experimental Models (3 ECTS)
MEC_4MF06_TA	Numerical Modelling in Fluid Mechanics (3 ECTS)
MEC_50518_EP	Bibliographical Study (4 ECTS)
MEC_53661_EP	Fluid Sturcture Interactions (3 ECTS)

Internship:

MEC_54598_EP	Internship (8 semaines) (18 ECTS)

M1 & M2 EXCHANGE @ ENSTA THROUGH IP-PARIS

MSc Offwind - Offshore Wind Energy (M1 Only) (in English)

M1 Semester 1 Courses:

Core Course Bloc:

X-MEC559	Mechanics for Wind Energy (3 ECTS)
X-PHY559B	Power Electrical Engineering for Renewable Energy (3 ECTS)
	Waves & Vibrations (3 ECTS)
	Structural Mechanics (3 ECTS)
	Soil Mechanics (3 ECTS)
	Reinforced & Prestressed Concrete (3 ECTS)
	Steel Construction (3 ECTS)
	Life Cycle Analysis (3 ECTS)
	Composite Materials (3 ECTS)
	Fatigue of Materials & Structures (3 ECTS)

M1 Semester 2 Courses:

Core Course Bloc:

AE-11	Fluid-Structure Interactions (3 ECTS)
	Numerical Methods for Fluid & Solid Mechanics (3 ECTS)
	Offshore Structures (3 ECTS)
	Design of Geotechnical Structures (3 ECTS)
	Plasticity & Fracture Design (3 ECTS)
	Failure Detection by Data-Sensing AI - Digital Twins (3 ECTS)
	Electrical Machinery & Grid Connection (3 ECTS)
	Project (3 ECTS)
	Demonstrators & Labs (3 ECTS)

Internship

Internship (8-10 weeks) (4 ECTS)