



MASTER'S IN NUCLEAR ENERGY

Courses and Syllabus

BECOME_{THE} ENGINEER
WHO MAKES LOW-CARBON POWER POSSIBLE

Courses and Syllabus

Your future study location

A new generation of advanced nuclear technologies offers unparalleled power, speed, and scalability to accelerate the transition to a low-carbon, or even post-carbon, energy landscape. At the same time, innovations in waste management have dramatically reduced risk and negative environmental impact.

Experts worldwide agree on nuclear energy's potential in the fight against climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC) highlights the need for nuclear energy to achieve rapid decarbonisation. In fact, nuclear energy is one of the four most promising pathways that could limit global warming by 1.5°C by 2050!

Carbon-free nuclear power is a critical part of the decarbonisation equation. Nuclear sector pays the highest in the energy sector and provides long terms careers according to a recent study (Oxford Economics, 2019, Nuclear Power Pays). This 2-year master's programme offers the possibility to learn from different top universities in countries where nuclear power is very strong and the connections between academia and the industry have been forged for decades.

Year 1

You can choose to attend either

- KTH: Royal Institute of Technology in Stockholm or
- UPC: Universitat Politècnica de Catalunya · BarcelonaTech

Where you take core modules in the fundamentals of nuclear engineering, safety and radiation protection, as well as design and management of power plants.

Alongside your technical studies, you follow an Innovation and Entrepreneurship track with Esade Business School that runs across both years. It includes a two-week summer school in Barcelona at the end of your first year, where you apply innovation and design-thinking techniques to a nuclear Business Case Challenge of your own design.

Year 2

You move in France – a nuclear powerhouse in Europe. With over 50 nuclear reactors, there is no better place to study nuclear energy in context. You will choose to study either in Grenoble or in Paris.

If you choose to study in Grenoble, you attend Grenoble INP where you can specialise in Materials for Nuclear Energy. If you choose to study in Paris, you follow a set of common courses taught at Université Paris-Saclay (INSTN) by Professors and experts from all Paris-based universities. Then, you continue on different tracks, depending of your specialisation.

The **Year 2** specialisations, and their corresponding institutions are:

- Grenoble INP (G-INP): Materials for Nuclear Energy (MaNuEn)
- Université Paris-Saclay (UPSay-CentraleSupélec): Operations (O)
- Université Paris-Saclay (UPSay-INSTN): Nuclear Reactor Physics and Engineering (NRPE)
- Université Paris Sciences et Lettres (PSL-ENSCP): Fuel Cycle (FC)
- École des Ponts ParisTech (ENPC): Decommissioning and Waste Management (DWM)
- Institut Polytechnique de Paris (IPP-ENSTA): Nuclear Plant Design (NPD)

Upon completion of the two years, you will obtain a double degree consisting of a degree from your Year 1 university and a degree from the Year 2 university where you followed your specialisation.

Special cases

In a small number of situations where eligibility rules require it, students spend Year 1 at Grenoble INP and Year 2 at KTH. The Programme Coordination team contacts any affected candidate directly and in advance.

Your master's thesis

..... You complete your second and final year with a Master's Thesis, which you undertake at one of our industrial or research partners.

Your thesis should have a strong focus on innovative solutions, and should be aligned with research or technology projects in nuclear energy. Working on your thesis gives you privileged access to some of the most prestigious companies, research centers, and installations in Europe. Their experts become mentors for your research.

Your thesis corresponds to five months of full-time study and is worth 30 European Credit Transfer and Accumulation System credits (ECTS).





YEAR 1

COURSES & SYLLABUS



KTH Royal Institute of Technology

Required credits

60

ECTS

Mandatory credits

23

ECTS

Elective credits

37

ECTS

Additional information and further requirements:

During Year 1, students following the Master of Science in Energy Innovation track at KTH must follow the courses below

Course name	Course code	ECTS	Course type
<u>Nuclear Reactor Physics, Major Course</u>	SH2600	9	Mandatory
<u>Thermal-Hydraulics in Nuclear Energy Engineering</u>	SH2701	6	Mandatory
<u>Nuclear Reactor Technology</u>	SH2702	8	Mandatory
<u>Radiation, Protection, Dosimetry and Detectors</u>	SH2603	6	Elective
<u>Nuclear Power Safety</u>	SH2612	6	Elective
<u>Nuclear Physics</u>	SH2302	8	Elective
<u>Radiation Damage in Materials</u>	SH2605	6	Elective
<u>Leadership for Safe Nuclear Power Industry</u>	SH2610	6	Elective
<u>Small Reactors</u>	SH2611	6	Elective
<u>Generation IV Reactors</u>	SH2613	6	Elective
<u>The Nuclear Fuel Cycle</u>	SH2614	6	Elective
<u>Monte Carlo Methods and Simulations in Nuclear Technology</u>	SH2704	6	Elective

Course name	Course code	ECTS	Course type
<u>Compact Reactor Simulator-Exercises in Reactor Kinetics and Dynamics</u>	SH2705	6	Elective
<u>Sustainable Energy Transformation Technologies</u>	SH2706	9	Elective
<u>Chemistry and Physics of Nuclear Fuels</u>	SH2772	8	Elective
<u>Numerical Methods in Nuclear Engineering</u>	SH2774	6	Elective

Universitat Politècnica de Catalunya

Required credits

60

ECTS

Mandatory credits

46,5

ECTS

Elective credits

13,5

ECTS

Additional information and further requirements:

During Year 1, students following the [Master in Nuclear Engineering](#) track at UPC must follow the courses below. Each elective course will only be offered if a minimum number of students is taking it. A survey will be organised at the end of the first semester in order to know the preferences of the students.

Course name	Course code	ECTS	Course type
Fundamentals of nuclear engineering and radiation protection	240NU011	8	Mandatory
Systems, components and materials	240NU012	6	Mandatory
Reactor Physics and Thermal Hydraulics	240NU013	7,5	Mandatory
Fuel Cycle and Environmental Impact (FCEI)	240NU014	5,5	Mandatory
Course Project 1	240NU015	3	Mandatory
Regulations and Safety	240NU021	5	Mandatory
Management of nuclear power plants	240NU022	8,5	Mandatory
Course Project 2	240NU023	3	Mandatory
Monte-Carlo methods for radiation transport calculation	240NU215	4,5	Elective
Nuclear Instrumentation	240NU216	4,5	Elective
Computational Fluid-Dynamics Applied to Nuclear Technology	240NU217	4,5	Elective

Course name	Course code	ECTS	Course type
Core Design	240NU213	4,5	Elective
Social Sciences and Humanities in Nuclear Energy	240NU218	4,5	Elective
Nuclear Fusion Technology	240NU211	4,5	Elective





YEAR 2

COURSES & SYLLABUS



Grenoble INP: Institute of Technology

Required credits

60

ECTS

Mandatory credits

60

(Including Master Thesis and internship)

ECTS

Additional information and further requirements:

During Year 2, students following the Material Science for Nuclear Energy (MaNuEn) track must follow the courses below.

Course name	Course code	ECTS	Course type
Materials and new Reactors	UE 1	6	Mandatory
Materials in nuclear environment	UE 2	6	Mandatory
<u>Materials and process challenges in reactors</u>	UE 3	6	Mandatory
<u>Nuclear Fuels</u>	UE 4	6	Mandatory
Strategy and innovation in the energy sector	UE 5	6	Mandatory
<u>Master Thesis</u>	UE 6	30	Mandatory



Master in Nuclear Energy (Paris)

Required credits

60

ECTS

Mandatory credits

60

(32 common +
28 specific track)

ECTS

Additional information and further requirements:

During Year 2, students following the Master in Nuclear Energy track must follow the common courses below, plus one of the five different internal options:

- Nuclear Reactor and Physics Engineering (supported by INSTN)
- Nuclear Plant Design (supported by ENSTA-Paris)
- Operation (supported by CentraleSupélec)
- Fuel Cycle (supported by Chimie Paris-Tech)
- Decommissioning and Waste Management (supported by École des Ponts Paris-Tech and CentraleSupélec)

Course name	Course code	ECTS	Course type
Introduction to Safety - Safety & Criticality	S3-C-SAFE	3	Mandatory
Radiation Protection	S3-C-RP	3	Mandatory
PWR Functional Description	S3-C-ENER	3	Mandatory
Nuclear Fuel Cycles. Nuclear Reactor Systems	S3-C-SYS	3	Mandatory
Energy transition, flexibility	S3-C-TRANS	2	Mandatory
Internship	S4-C-INTER	18	Mandatory
Courses depending on each track		28	Mandatory

Université Paris-Saclay (UPSay)

Required credits

28

ECTS

Mandatory credits

28

ECTS

Additional information and further requirements:

In Year 2, students following the Nuclear Reactor Physics and Engineering (NRPE) track must follow the below courses.

Course name	Course code	ECTS	Course type
Thermohydraulics	S3-D-O-R-FLUI	4	Mandatory
Nuclear Physics	S3-R-NUCL	4	Mandatory
Nuclear Materials	S3-R-MAT	4	Mandatory
Reactor Physics and Simulation	S4-R-RPS	2	Mandatory
Neutronics1	S3-R-NEUT	4	Mandatory
Neutronics 2	S4-R-NEUT	4	Mandatory
Advanced Thermohydraulics	S4-R-FLUI	4	Mandatory
Multiphysics & Uncertainties	S4-R-MPHYS	2	Mandatory



Institut Polytechnique de Paris (IPP)

Required credits

28

ECTS

Mandatory credits

28

ECTS

Additional information and further requirements:

In Year 2 students following the Nuclear Reactor Physics and Engineering (NRPE) track must follow the below courses.

Course name	Course code	ECTS	Course type
Risk Management	S3-F-W-D-O- RISK	4	Mandatory
Thermohydraulics	S3-D-O-R-FLUI	4	Mandatory
Applied Nuclear Physics and Neutronics	S3-D-O-NEUT	3	Mandatory
Material Physics: Concrete	S3-D-CON	2	Mandatory
From Seismology to Earthquake Engineering	S3-D-SEISM	2	Mandatory
Calculation Code	S3-D-CODE	3	Mandatory
Material Physics: Corrosion	S3-D-CORRO	1	Mandatory
Design	S4-D-DESI	2	Mandatory
System & Equipment	S4-D-SYST	4	Mandatory
Numerical Design	S4-D-NUMDESI	3	Mandatory



Université Paris-Saclay (UPSay)

Required credits

28

ECTS

Mandatory credits

28

ECTS

Additional information and further requirements:

In year 2, students following the Operations(O) trunk must follow the below courses:

Course name	Course code	ECTS	Course type
<u>Risk Management</u>	S3-F-W-D-O-RISK	4	Mandatory
Thermohydraulics	S3-D-O-R-FLUI	4	Mandatory
Applied Nuclear Physics and Neutronics	S3-D-O-NEUT	3	Mandatory
Operation Management	S3-O-OPER	3	Mandatory
Control-Command and Code Simulation	S4-O-CODE	4.5	Mandatory
Maintenance	S4-O-MAIN	4	Mandatory
Safety & Production	S4-O-SAFE	4	Mandatory
Non Destructive Testing	S4-O-NDT	1.5	Mandatory

Paris Sciences et Lettres (PSL)

Required credits

28

ECTS

Mandatory credits

28

ECTS

Additional information and further requirements:

In year 2, students following the Fuel Cycle(FC) trunk must follow the below courses:

Course name	Course code	ECTS	Course type
Risk Management	S3-F-W-D-O-RISK	4	Mandatory
Introduction to Nuclear Physics, Neutronics	S3-F-W-NPN	2	Mandatory
Fuel: from Mine to Reactor	S3-F-FUEL	3	Mandatory
Separation & recycling	S3-F-SEPA	4	Mandatory
Cooling and Molten Salt	S3-F-CMS	3	Mandatory
Actinides Electronic Structure and Spectroscopy	S3-F-SPEC	2	Mandatory
Process Simulation & Process Control	S4-F-CODE	3	Mandatory
Containment Waste	S4-F-STO	4	Mandatory
Radioactive Waste Management & Design	S4-F-WAST	3	Mandatory

École Nationale des Ponts et Chaussées (ENPC)

Required credits

28

ECTS

Mandatory credits

28

ECTS

Additional information and further requirements:

In year 2, students following the Decommissioning and Waste Management(DWM) trunk must follow the below courses:

Course name	Course code	ECTS	Course type
<u>Risk Management</u>	S3-F-W-D-O-RISK	4	Mandatory
Introduction to Nuclear Physics, Neutronics	S3-F-W-NPN	2	Mandatory
Dismantlement & Decommissioning Nuclear facilities	S3-W-DIS	5	Mandatory
Politics, Strategy and Management Decommissioning	S3-W-DECO	5	Mandatory
Calculation Code 1	S4-W-CODE1	2	Mandatory
Calculation Code 2	S4-W-CODE2	2	Mandatory
Methods of Decommissioning	S4-W-DECO	4	Mandatory
Waste Management	S4-W-WAST	4	Mandatory





STUDY PLAN

Our Academics+ approach ensures that you have access to many more activities next to the courses provided by the technical universities. Each programme offers its unique set of activities such as field trips, summer & winterschools, industrial visits, case-based learning, real-life energy projects, and more.



Industrial Visits

Year 1, students will have the opportunity to attend several field visits depending on their host university: Students following their first year of studies at Universitat Politècnica de Catalunya ·Barcelona Tech (UPC) take part in industrial site visits including ENSA factory (large equipment) in Santander, Sta. Maria de Garoña, a decommissioning Nuclear Power plant (both visits are combined in a 2-3 days trip), and the full-scope simulator of Tecnatom in Vandellòs (students are driven to the place daily for the training during three consecutive days, or are accommodated in a nearby hotel if the training is at odd hours). Students are also invited to participate in the Seminar on Operating Experiences organized by the Spanish Nuclear Society at the beginning of the spring semester (this takes place within a 2-3 days trip to Madrid in which students will also visit Endesa and Tecnatom headquarters).

The Nuclear Fuel Cycle course at KTH includes a few-day field trip to CLAB (the central interim storage facility for spent nuclear fuel), Äspö hard rock laboratory, the spent fuel encapsulation plant, and a field trip to the Westinghouse fuel factory in Västerås. The field trip takes place at the end of October. KTH Y1 students will participate in a training activity at the VR-1 reactor in Prague.

In Year 2, field visits to nuclear sites across France during your time in Paris are determined by your choice of elective courses. Fieldtrip destinations include Flamanville, Tricastin, Marcoule, Melox, and La Hague. These visits incorporate every aspect of the industry, from fuel and energy production, waste recycling, and command center simulations. Learn about day-to-day operations in a nuclear plant with EDF simulators and the CEA's EVOC simulator.

Second-year students at Grenoble INP opted for focusing on nuclear materials, from nuclear fuel to nuclear components. Among other courses, two unique "on site" courses give unique access to nuclear installation sites as well as hands-on activities on nuclear facilities: (i) a three-week course at CEA Cadarache in France, including visits of hot laboratories handling irradiated materials and ITER; and (ii) a 1-week course at the EDF Material Aging Institute in France, looking at critical material challenges for the lifetime extension of operating Pressurized Water Reactors.

Nuclear societal challenge

During the Year 1 students at UPC immerse into Nuclear Societal Challenge to deeper understand the context of nuclear energy. Faced with various project-based learning activities (challenges to be addressed in team), you analyse the impact of decisions surrounding nuclear energy (e.g. what would be the societal impact of shutting down or constructing a nuclear facility in terms of jobs, economy and alternative energy supply?) You will learn to analyse not only immediate and future impacts, but also responsibilities that will come with such decisions.

One special aspect, considered at UPC in a short but mandatory module (2 ECTS) and at KTH in one elective course (6 ECTS), is that of new generation reactors, with a focus on the small modular reactors. Students carry out a project, during a part of the second semester, in which they analyse different technical, environmental and social aspects of planning and constructing a new plant of this type, in clear alignment with the Nuclear Societal Challenge described above.

Esade Business School

Esade Business School is responsible for your Innovation and Entrepreneurship formation. Learning material is organized in three modules, Module 1, Module 2 and Summer School. Module 1 and Module 2 take place during the first year in February and April, respectively, while two weeks of Summer School (at Esade, Barcelona) are organized for the end of June and beginning of July.

In these sessions, you will explore:



Lean start-up and design thinking techniques



How to identify entrepreneurial opportunities



Managing business under uncertainty



Different business models and their applications



Intercultural leadership and team management

At Esade, you will bring new understanding and innovation techniques to bear on your Business Case Challenge, designing your own dream tech nuclear solution for challenges like climate, space, safety, or hybrid nuclear-renewable energy systems.

In Year 2, you will continue to follow the Innovation & Entrepreneurship Journey, providing a unique education that combines industrial practice, innovation and entrepreneurship expertise, and advanced leadership skills.

Green Seed Journey

The Green Seed Journey is an online entrepreneurship competition designed for allInnoEnergy Masters+ students.

You get immersed in an online entrepreneurial ecosystem. During 6 months, you transform your bright ideas into promising business while competing with peers, interacting with virtual investors from top business schools around the world and get advice from experienced business creation professionals.

Projects and Challenges

As a follow-up to the project on Small modular reactors, students from Grenoble INP will be given the opportunity to get to know more about one of the most promising reactor designs: Molten Salt reactors. In a dedicated course on Molten Salt reactors and Molten Salt technologies. LPSC unique research platform on Molten Salt (part of SAMOFAR, Euratom research project), will be adapted to allow practical teachings on Molten Salt technologies. Challenge-based projects in collaboration with Seaborg Tech start-ups are organized depending on industrial opportunities.

Students have the opportunity to tackle a unique challenge-based project on additive manufacturing for nuclear components. This project is proposed by French industrial partners who are eager to explore cutting-edge manufacturing technologies. Managed by Grenoble INP, this activity is also open to students from every Year 2 University to participate.

A new shared activity will be launched this year: Material selection for low-carbon system. It will explain in detail the main materials used for low carbon systems, how they are selected, and the key engineering properties will be presented. Then, in a second part, the role of materials in the energy transition will be detailed, focusing on the main challenges in terms of materials and resources, as well as the materials intensity of the different energy systems. This activity will allow EMINE students to join teams with students who are experts in renewables or grids, to work on a better energy mix.

Data science & AI for energy track

Data Science & AI for Energy: Master+ will offer you the chance to follow several courses to equip yourself with practical skills in data science and AI for the energy sector, either in an engineering context or to create new business models.

You can explore key modules such as:

Data Science & AI for Energy



Data-driven business decision making



Digital business & venturing for energy engineers



These courses prepare students to enable change in the digital energy industry and land promising careers as energy analysts in large consultancy firms or digital innovators in start-ups or large corporations. After completion of these courses, you will receive a master certificate from InnoEnergy.



Careers+

In addition to strong academics, Careers+ offers a wide range of services to support your professional growth. These include **CV writing support**, **career webinars**, and access to the **Career Services Group**. You'll also take part in hands-on experiences like the **Career Impact Challenge**, **hackathons**, and the **Virtual Career Fair**, as well as stay informed through dedicated job boards featuring exclusive opportunities across Europe.

Careers+ also gives you access to key industry events such as Connect (flagship Masters+ student event bringing together all students from different universities and programmes), **Enlit** (Europe's leading energy event, with free access and accommodation provided by InnoEnergy), and **TBB – The Business Booster** (InnoEnergy's annual international networking event showcasing 200+ sustainable energy innovations, where selected students support start-ups, meet investors, and explore how to attract interest in future ventures).

Careers+



CV writing
support



Career
webinars



Career Services
Group

CommUnity+

CommUnity+ complements the academic experience by providing opportunities for students to engage with peers, alumni, and professionals. The programme begins with **welcome events** at each university location to help students connect and prepare for the academic year.

Throughout the programme, students can participate in activities such as **alumni talks**, **company visits**, **case-based events**, **cultural gatherings**, and **expert-led online sessions**. CommUnity+ also includes the **Leader Summit**, a three-day meeting for student volunteers focused on team building and planning activities for the year. Additional resources include the **InnoStation Podcast**, featuring interviews with industry leaders, and a **quarterly newsletter** with updates on recent and upcoming initiatives.

The **CommUnity+ online platform** provides access to **event listings**, **mentoring opportunities**, **topic groups**, and **recordings of past sessions**, supporting continuous engagement across locations.

CommUnity+



Alumni talks



Company visits



Case-based
events



Cultural gatherings



Expert-led online sessions

DEGREES AND CERTIFICATIONS

After successfully completing the programme, you will receive a degree from each of your chosen universities:



KTH: Royal Institute of Technology:

Master of Science in Energy Innovation (TIETM)



UPC: Universitat Politècnica de Catalunya

Master in Nuclear Engineering



Grenoble INP: Institute of Technology:

Master Materials of Science : Materials Science for Nuclear Energy



Université Paris-Saclay:

Master of Science in Energy Innovation (TIETM)



Université Paris Sciences et Lettres (PSL):

Master of Science, Technology, Health, mention Nuclear Engineering (**FR:** Master of Science, Technologie et Santé, Mention Ingénierie nucléaire)



Université Paris-Saclay:

Master of Science, Technology, Health, mention Nuclear Engineering (**FR:** Master of Science, Technologie et Santé, Mention Ingénierie nucléaire)



Institut Polytechnique de Paris (IPP):

Master of Science, Technology, Health, mention Nuclear Engineering (**FR:** Master of Science, Technologie et Santé, Mention Ingénierie nucléaire)



Esade Business School:

Certificate of Academic Participation in the Innovation & New Venture Creation



EIT Label certificate:

A certificate of quality awarded by the European Institute of Innovation and Technology (EIT) to students of educational programmes that excel in innovation, entrepreneurship, and creativity.



Digitalisation for Energy Engineers:

Students can choose to take optional courses and earn additional certificates from those courses upon completion.

The EIT Label is a quality seal awarded by the European Institute of Innovation and Technology (EIT) to a KIC educational programme that has been assessed positively by the EIT on the implementation of the EIT Quality Assurance and Learning Enhancement (EIT QALE) system and the application of specific quality criteria with focus on the EIT Overarching Learning Outcomes (EIT OLOs), robust entrepreneurship education, highly integrated, innovative 'learning-by-doing' curricula, international mobility and outreach.

InnoEnergy continually strives to improve the quality, structure, and content of our Masters+ programmes. Therefore, some changes may occur as part of our quality control process.





MASTER'S IN NUCLEAR ENERGY

[LEARN MORE](#)

