

## Master in Materials science and engineering

# Materials for nuclear energy 2nd year

### Presentation

---

The master in MaNuEn - Materials for Nuclear Energy - is an international master designed for students wishing to pursue a career in the nuclear industry, in R&D or working for research organisations. MaNuEn is a 2-year master that aims to cover the specificities of the materials used in the nuclear environment, whether fuel or components, with a particular focus on the durability of materials under irradiation. The second year of the master MaNuEn is shared with the [Master of Science Innovation in Nuclear Energy - EMINE](#) (first year at KTH in Sweden or the UPC in Spain).

The content of the program and courses was developed in collaboration with engineers from EDF and CEA. The second year takes place over two semesters : all the courses of the master are taught in the first half (september to january) : 2 specialised courses taught at CEA Cadarache (3 weeks in december) and the Materials Ageing Institute (2 weeks in january at EDF in Les Renardières) are part of the curriculum.

Start of the new academic year : early september

### Objectives

---

Train engineers or researchers in aspects related to materials and their durability in the nuclear field

### Registration and scholarships

---

To be accepted for a master 2nd year, you must hold a master 1 degree or equivalent. Your previous studies must be compatible with the master you wish to study. The recruitment and registration conditions are stated for each speciality.

See Grenoble INP website : <http://www.grenoble-inp.fr/fr/formation/les-admissions>

### Further studies

---

All doctoral schools in physics or materials, for example ED IMEP2 or ED physics in Grenoble

### Practicals informations :

---

- > **School** : Grenoble INP
- > **Duration** : 1 year
- > **Course type** : Initial and Continuing Education
- > **Location(s)** : Grenoble - University campus
- > **Contacts** :

#### Programme director

Luc Salvo  
Luc.Salvo@grenoble-inp.fr, Luc.Salvo@ujf-grenoble.fr

#### Programme administration

Eliane Zammit

Eliane.Zammit@grenoble-inp.fr

## Program

<p><b>Semestre 3 M1 RI MANUEN</b></p> <p><b>UE 1 Fundamental Aspects of Materials S3</b> Development – Part 1 – 4PMME134 Phase Transformations – 4PMMTP34</p> <p><b>UE 2 Fundamental Aspects of Materials S3</b> Polymers – 4PMFPOL5 Microstructures and Properties – 4PMMMN34</p> <p><b>UE 3 Applied Materials S3</b> Physics of Functional Materials – 4PMFPM34 Major Classes of Materials – 4PMMGCM4</p> <p><b>UE 4 Numerical Modelling</b> Numerical Methods – 4PMFNUM4 Finite Element Projects – VPMUFEM4</p> <p><b>UE 5 Physics and Language</b> Solid-State-Chemistry – 4PMFCHS4 English – VPMUANG3 VPMFCRI2 : Crystallography – VPMXCRI4</p>	<p><b>Semestre 5 M2 RI MANUEN</b></p> <p><b>UE 1 Reactor concepts and materials</b> Fundamentals in materials science – 5PMUFMS4</p> <p><b>BLOC 12 Nuclear reactor coolants</b> Liquid Metals Technology – 5PMULME4 Liquid Metals Technology – 5PMULMT4</p> <p><b>BLOC 11 Reactor Design</b> Gen IV – 5PMUGEN4 Operations of nuclear reactors – 5PMUONR4 Reactor Design – 5PMURED4</p> <p><b>BLOC 13 Materials for reactors</b> Choice of materials – 5PMUCHM4 Description and Operation of NPP – 5PMUDON4 EDF activity on Materials and Structures – 5PMUEDF4 Material selection – 5PMUMAS4 Material used in nuclear reactor – 5PMUMNR4</p> <p><b>UE 2 Material ageing in nuclear environment</b></p> <p><b>BLOC 22 Corrosion and fracture mechanics</b> Fundamental of corrosion – 5PMUFCO4 Fracture mechanics – 5PMUFME4 Nuclear corrosion – 5PMUNCO4</p> <p><b>BLOC 21 Materials under irradiation</b> Dislocations – 5PMUDIS3 Irradiation ageing – 5PMUIRA4 Irradiation defects – 5PMUIRD4 Microstructure – 5PMUMIC4</p> <p><b>UE 3 Energy and Components EDF</b></p> <p><b>BLOC 32 Energy</b> General approach to energy – 5PMUGAE4</p> <p><b>BLOC 31 Components EDF</b></p> <p><b>BLOC 31a Chemistry and radioanalysis</b> Chemistry and radioanalysis – 5PMUCRD4</p> <p><b>BLOC 31b Civil works</b> Civil works – 5PMUCOMF</p> <p><b>BLOC 31c Corrosion and thermal effect</b> Corrosion in secondary circuit – 5PMUCOMH Thermal ageing – 5PMUCOMI Corrosion (Primary circuit) – 5PMUCOMJ Thermal fatigue – 5PMUCOMK Corrosion (Fundamentals) – 5PMUCOMP</p> <p><b>BLOC 31d Fuel</b> Fuel – 5PMUCOMG</p>
<p><b>Semestre 4 M1 RI MANUEN</b></p> <p><b>UE 6 Development and Characterisation Methods</b> Analytical and Microstructural Characterisation Method Development – Part 2 – 4PMME144</p> <p><b>UE 7 Applied Materials S4</b> Materials Science of Thin Films – 4PMMTP44 Practical Assignments in Materials Science – Part 2 – 4PMME144</p> <p><b>UE 8 Plasticity and Modelling</b> 4PMFMME5 : Multi-scale Modelling – 4PMXMME5 Introduction to Solid Mechanics – VPMUIMS6 Plasticity and Thermomechanical Processing – VPMUTMT6</p> <p><b>UE 9 Vocational Training</b> VPMFSTA4 : Internship – VPMUTMT6</p>	

<b>BLOC 31e Reactor pressure vessel and internals</b>	Introduction to design – 5PMUNUCB		
Internals – 5PMUCOMC	Fuel element design – 5PMUNUCF		
Welding and RPV – 5PMUCOMD	<b>BLOC 43 Nuclear fuels behavior under</b>		
Reactor pressure vessel – 5PMUCOME	Film – 5PMUNUCD		
<b>BLOC 31f Non destructive testing</b>	Irradiation effect – 5PMUNUCE		
Non destructive examination – 5PMUCOMA	Fission gas – 5PMUNUCG		
<b>BLOC 31g Polymers</b>	Off normal – 5PMUNUCH		
Polymers – 5PMUCOMB	Fuel modelling – 5PMUNUCI		
<b>BLOC 31h Maintenance, ageing and fuel</b>	<b>BLOC 45 Visit and evaluation</b>		
Maintenance ageing and fuel reprocessing – 5PMUCOM	Evaluation – 5PMUNUCL		
<b>BLOC 31i Visit and evaluation</b>	Visit – 5PMUNUCM		
Visit – 5PMUCOMM	<b>UE 5 Foreign Languages and Project</b>		
Evaluation of formation and Closure – 5PMUCOMO	Numerical Simulation – 5PMUNUS5		
<b>UE 4 Nuclear fuels CEA</b>	English or French languages (choose to make up a total of 2.0)		
<b>BLOC 42 Nuclear fuel fabrication</b>	English or another language – 5PMCANG0		
Fuel fabrication and characterization – 5PMUNUCC	French – WPMUFRA3		
<b>BLOC 44 Nuclear fuel cycle</b>		0.0	16.0
Fuel cycle – 5PMUNUCJ		0.0	13.0
Scenarios – 5PMUNUCK		0.0	3.0
<b>BLOC 41 Nuclear fuel design</b>		0.0	15.0
Design methodology – 5PMUNUCA		0.0	3.0
	<b>Semestre 6 M2 RI MANUEN</b>		
	<b>UE 6 Master internship</b>		
	Master internship – WPMUSTA4		