INFORMATION

• Venue
  The courses will be held at INSTN locations in Saclay (20 km southwest of Paris), Cadarache (40 km from Aix-en-Provence) and Marcoule (10 km from Orange).

• Registration deadline
  November 29, 2017

• Registration fee
  Professional: €700 for the first course, €1200 for each additional course.
  Students: €400 for each course.
  CEA, ENEN member institutions: special rates.
  Fee covers lectures, documentation and lunches.

• Contacts
  Programme manager: Claude Renault - claude.renault@cea.fr
  General coordination and information: Nadia Nowacki - nadia.nowacki@cea.fr

6 Doctoral-level Courses
in Nuclear Engineering
From January 29 to February 9, 2018

Saclay
Thermal Hydraulics and Safety
January 22 to 26, 2018
Materials for Nuclear Reactors, Fuels and Structures
January 23 to February 2, 2018
Contact for registration: Corinne Carreaux - corinne.carreaux@cea.fr

Cadarache
Reactor Core Physics: Deterministic and Monte Carlo Methods
January 22 to 26, 2018
Nuclear Fuels for Light Water Reactors and Fast Reactors
January 29 to February 3, 2018
Contact for registration: Béatrice Jacob-Silvestri - beatrice.jacob-silvestri@cea.fr

Marcoule
Nuclear Fuel Cycle: from Strategy to Processes
January 29 to February 2, 2018
Nuclear Waste Management
February 3 to 9, 2018
Contact for registration: Nathalie Nowazend - nathalie.nowazend@cea.fr
# About the School

The National Institute for Nuclear Science and Technology (INSTN) is organizing the International School in Nuclear Engineering, aiming at promoting knowledge in the field of nuclear sciences at a high education level.

- The 2018 edition will offer 6 one-week advanced courses in nuclear engineering to be held in France (Cadarache, Marcoule, or Saclay), in January and February 2018.
- The courses are designed for young researchers, PhD students, post-doctorates and engineers, already having a Master of Science in nuclear engineering as a background. The courses will present the international state-of-the-art in the main topics of nuclear engineering: reactor core physics, thermal hydraulics, materials, fuels, fuel cycle, nuclear waste.
- 3 ECTS will be awarded for each successfully completed course (one week).
- Lecturers are internationally known experts mostly from CEA, the leading research organisation in France for nuclear energy.

# Outline Programme of Courses

For each course technical visits of CEA facilities are planned.

## Reactor Core Physics: Deterministic and Monte Carlo Methods (C. Diop, A. Santamarina)

- Chain reaction and neutron balance
- Neutron slowing-down and resonance absorption, self-shielding modelling
- The neutron transport equation and calculation schemes: the steady-state integro-differential transport equation. The neutron diffusion equation... Verification and validation of neutronics code package: process, sensitivity and uncertainty studies
- The Monte Carlo method for solving the transport equation
- Monte Carlo techniques: fixed source, variance reduction, criticality, perturbation calculations, adjoint calculation, applications to shielding

## Thermal Hydraulics and Safety (D. Bestion, J-M. Bonnet, E. Studer)

- Basic modelling of two-phase flow
- Two-phase flow phenomena in LWRs
- Multi-scale approach of LWR thermal hydraulics
- System code modelling of reactor thermal hydraulics, including advanced modelling
- Simulation of LWR design basis accidents
- Application of two-phase CFD to reactor thermal hydraulic issues
- Multiphase phenomena and modelling of severe accidents in LWRs
- Hydrogen risk (production, dispersion, combustion, mitigation)

## Materials for Nuclear Reactors, Fuels and Structures (J-L. Béchade, J-C. Brachet, J. Garnier, F. Garrido)

- Mechanisms of irradiation damage: neutrons, photons, electrons
- Behaviour of materials under irradiations: ferritic steels for reactor pressure vessel, austenitic stainless steels for internals or fuel cladding (PBR), Zr alloys for fuel cladding and fuel assemblies (LWR)
- Fuel materials (UO₂, PuO₂): irradiation-induced effects
- Materials for high temperature conditions: SiC, ZrC, low swelling alloys
- Materials for fusion: low activation materials, resistance to high-energy neutrons, breeding blankets

## Nuclear Fuels for Light Water Reactors and Fast Reactors (D. Pannet, J. Nonnot)

- Nuclear fuels fundamentals
- Fuel element thermal performance and temperature effects

## Nuclear Fuel Cycle: from Strategy to Processes (Ch. Poinssot, Ph. Moisy)

- Introduction to fuel cycle strategy
- From uranium ore mining to spent nuclear fuel
- Fundamentals of fuel cycle: chemistry of actinides and fission products
- The current industrial process: scientific basis and process modelling
- Towards the 4th generation nuclear energy systems: scientific and industrial challenges associated to the Pu-multirecycling
- Minor actinide recycling as a potential option for waste management optimization

## Nuclear Waste Management (J. Ribet, C. Coux Dit Coumes, S. Gin)

- General considerations on nuclear waste
- Waste conditioning (with emphasis on glass and cement-like materials)
- Waste storage and disposal