# Course on “Basic operation of nuclear reactors” (3 ECTS)

## Units and LO Statements

### Unit 1 – Principles of a nuclear reactor (15 hours)

**Responsibility / Autonomy**

Figure out the principles of nuclear reactors (EQF=7)

**Skills**

- Integrate and apply theory and kinetics of nuclear reactors.
- Apply reactor thermal hydraulics.
- Approach and manage the reactor operation.
- Explain physics underlying the reactor operation.
- Assess safety principles and background

**Knowledge**

- Basic nuclear interaction in a reactor core
- Main core elements
- Reason for moderating neutrons
- Reason for core stability
- Reactivity variation and management
- Core thermal hydraulics and heat transfer main characteristics
- Safety principles
- Safety analysis

### Reactor principle and systems

- Neutron interaction, Cross section, Fission
- Reactor principle, Reactor systems
- Examples of Research and Industrial reactors

### The neutron kinetics

- Equations of kinetics
- Study of the critical state
- Sub- and Super-critical states

### Thermal hydraulics.

- Water as a coolant: fluid properties
- Energy balance and fuel temperature
- Heat transfer in (research) reactors
- Pressure drops and coolant flow rate
- Thermal and hydraulic design

### Basic safety

- General principles
- Safety Analysis Methods
- Performance of Safety Analysis
- Case study

### Unit 2 – Basic operation of a nuclear reactor (15 hours)

**Responsibility / Autonomy**

Operate a nuclear reactor (EQF=7)

**Skills**

- Approach and manage the reactor operation.
- Explain physics underlying the reactor operation.
- Operate an experimental reactor

**Knowledge**

- Reactivity variation and management
- Use of control rods
- Control rod efficiency measurement
- Main effects during core operation
- Complexity of a reactor system
- Links among the main reactor equipment
- Operational safety

### Reactor operation

- Operational aspects – limitation of the reactivity
- Reactor start up and operation
- Temperature effect
- Core poisoning (Xenon, Samarium)

### Practical course on the ISIS training reactor

- Fuel loading
- Approach to criticality
- Reactor start up and stabilization
- Manual and Automatic control
- Effect of the core loading modification
- Temperature effect

### Practical course on a software application

- PWR normal and accidental conditions

### Assessment criteria

- To demonstrate mastery of basic nuclear reactor physics and operation
Recommended assessment methods: Written test and/or oral face to face interview

Course applicable for the following job profiles:

- 1.0.01: Nuclear Safety Manager
- 1.0.02: Safety Assessment Specialist
- 1.0.10: Safety Design Engineer
- 1.2.01: Design Manager
- 1.2.09: System Design Engineer
- 2.0.01. Plant Manager
- 2.1.03. Production Manager
- 2.1.06. Engineering Manager
- 2.1.07. Operation Manager
- 2.1.04. Training Officer
- 2.2.01. Shift Engineer
- 2.2.02. Senior Reactor Operator/CRO
- 2.6.01. Safety and Security Manager
- 2.8.07. Reactor Physicist