



Language :	English
Place of the course	Autre site
Prerequisites	Courses in the following field <ul style="list-style-type: none"> · Nuclear reactor theory · Nuclear thermal hydraulics
Learning outcomes	<p>At the end of this learning unit, the student is able to :</p> <p><u>To introduce the students to methods and practices supporting the defense-in-depth approach for nuclear power plants.</u></p> <p><u>More specifically:</u></p> <ul style="list-style-type: none"> • To present elements of nuclear safety philosophy. • To understand how to insure the link between nuclear safety and reactor operation. <p>1</p> <ul style="list-style-type: none"> • To master all the contributors to the core reactivity balance and power distribution in normal operation. • To understand specific measurement and control issues in nuclear reactors. • To introduce the basic notions and techniques of system reliability engineering. • To understand the concepts of safety analyses (both deterministic and probabilistic), and the fundamentals of probabilistic safety analysis (PSA). • To present some PSA-based applications.
Evaluation methods	<p><u>Operation & Control</u></p> <p>First and second session: Individual oral exam, closed book, written preparation</p> <p><u>Reliability & Safety</u></p> <p>First and second session: An oral examination (closed book) with one question on the concepts and one exercise</p>
Content	<p><u>Operation & Control (28h)</u></p> <ul style="list-style-type: none"> • Cycle specific safety evaluation methodology. • Basic principles of the in-core fuel management based on the linear reactivity model. • Reactivity coefficients (moderator, Doppler), neutron poisons (xenon, samarium, '), their variation with burnup and core state parameters and their impact on core power distribution • Reactivity control means (boron, control rods, burnable poisons) and their sensitivity to the core burnup and in-core fuel management parameters. • Operating modes, operating limits and protection diagram. • Fuel rod design and thermal-mechanical behavior in normal operation and accidental conditions. • Thermal design procedures and elaboration of the core thermal limits and core protections. • Core control, surveillance and protection systems <p>Optional visits and laboratory session:</p> <ul style="list-style-type: none"> • Visit of a Nuclear Power Plant. • Two day session of compact and full scope Nuclear Power Plant simulator. <p>Seminars: Overview of design basis accidents and severe accidents; Discussion of selected past nuclear (severe) accidents (TMI, Chernobyl, Fukushima-Daiichi...)</p> <p><u>Reliability & Safety (14h theory + 6h exercises)</u></p> <ul style="list-style-type: none"> • Introduction to nuclear safety and defence in depth • concept of risk, individual and societal risk criteria, release limits, core damage frequency limit, safety goals at function or system level • deterministic vs. probabilistic safety analyses; • probabilistic safety assessment (PSA) methodology and PSA levels • Component reliability • Fault tree and event tree analysis • Markov analysis • Common cause failure analysis • Elements of human reliability analysis • Elements of the level 2 and level 3 PSA methodology • Limits of the classical PSA methodology

	<ul style="list-style-type: none"> • PSA-based applications
Inline resources	https://www.sckcen.be/fbnen
Other infos	<p>Course location: SCK-Cen (Mol)</p> <p>Prof. Greet Janssens-Maenhout -Universiteit Gent</p> <p>NN - Universiteit Gent</p> <p>Prof. Pierre- Etienne Labeau -Université Libre de Bruxelles</p>
Faculty or entity in charge	EPL

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mechanical Engineering	MECA2M	5		
Master [120] in Electro-mechanical Engineering	ELME2M	5		
Master [120] in Energy Engineering	NRGY2M	5		