NUCLEAR TECHNOLOGY EDUCATION CONSORTIUM

N01 REACTOR PHYSICS, CRITICALITY & DESIGN

Summary

Nuclear reactors now account for a significant portion of the electrical power generated world-wide. At the same time, the past few decades have seen an ever-increasing number of industrial, medical, military, and research applications for nuclear reactors. Reactor physics is the core discipline of nuclear engineering and deals with the physical processes in reactors which are fundamental to the understanding of both operational and safety aspects of nuclear reactors. This module provides a historical background to reactor development, considers the range of possible designs, and explains the underlying nuclear physics principles and models that underpin an understanding of nuclear reactor operations.

On completion students should be able to:

- Compare and contrast the range of nuclear reactor designs, reactor codes, and transport/diffusion theory models used in the industry today.
- Explain the physical principles which govern criticality, radioactive decay, reactor physics and kinetics, reactor system layout, and underlying nuclear processes which form the basis of how reactors work, run and are modeled in codes.
- Derive expressions for criticality formulae, diffusion and transport equations for a variety of given situations and layouts.
- Understand the importance of cross-sections, bucklings, delayed neutrons, six factor formula variables, the function of different parts of a nuclear reactor, and the crucial role played by neutronics in criticality and in the response of a multiplying system.
- Know some background connected to the historical, environmental, and socio-political aspects of the nuclear industry, and issues related to later decommissioning.
- Appreciate the need for knowledge of risk assessment, control, and safety for a reactor, and know about some of the consequences and issues connected with historical accidents.

Syllabus

- History of the industry
- Environmental and socio-political aspects of nuclear power
- Reactor design, different reactor types
- Advanced reactor design
- Reactor physics, cross sections
- Nuclear physics and radioactive decay
- Criticality calculations and neutronics
- Advanced Reactor Physics and neutron diffusion and transport theory
- End of life and decommissioning issues
- Containment and core layout
- Operational monitoring, reactor control and safety
- Accidents and risk assessment
- Reactor physics codes and models