CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Nuclear Sciences and Physical Engineering
Department of Nuclear Reactors

MIIS - NUCLEAR RESEARCH REACTOR PRACTICUM

SYLLABUS

PART A - GENERAL ISSUES

WELCOME MEETING

The course opening, course goals & scope, logistics and organisational issues, short presentation of the Czech Technical University and the Department of Nuclear Reactors. The course pre-test

POST-TEST

The course post-test

EVALUATION MEETING

The course evaluation, the analysis of pre-tests and post-tests results, feedback discussion and closing of the course

PART B – THEORETICAL LECTURES

HOW DOES A NUCLEAR REACTOR WORK?

How nuclear reactor works (basic principles of research reactor operation) - basic phenomena and principles, essential parts of a nuclear reactor, shielding, coolant, fuel, moderator, absorber, control rod, reflector, neutron source, detector, control system, differences between nuclear reactors and nuclear bombs

INTRODUCTION TO NEUTRON AND REACTOR PHYSICS

Nuclear interactions, cross sections, neutron interactions in a reactor, fission, fast and thermal neutrons, prompt and delayed neutrons, multiplication factor k_{eff}, relation of multiplication to reactor power, reactor power and its relation to neutron flux, neutron flux distribution in a reactor

CONSTRUCTION AND OPERATION OF NUCLEAR POWER PLANTS

Current, latest and future nuclear power plants designs (Gen II, III and IV), small and modular reactors and general operation of a nuclear power plant

INTRODUCTION TO SAFE AND SECURE OPERATION OF NUCLEAR REACTORS

3S concept of safe and secure operation of nuclear reactors (safety, security, safeguards), life cycle of research reactors, key players in the world of research reactors, basic principles of safety of research reactors, defence in depth, five levels of defence in depth, examples of defence in depth

NUCLEAR FUEL CYCLE OF A NUCLEAR REACTOR

Uranium mining, uranium ore processing, yellow cake and conversion to UF6, uranium enrichment, fuel fabrication, nuclear fuel in a nuclear power plant, uranium fuel in a reactor core, thorium and MOX fuels, new generation reactor fuels, used and spent nuclear fuel, used nuclear fuel storing, used nuclear fuel reprocessing, spent nuclear fuel

INTRODUCTION TO RADIATION PROTECTION AND RADIOACTIVE WASTE MANAGEMENT

Radiation sources in the environment and in a nuclear reactor, basic principles of radiation protection, ALARA principle, personal monitoring, environmental monitoring, and radioactive waste management in the operation of a nuclear installation

SAFEGUARDS AT A NUCLEAR REACTOR

Non-proliferation treaty, comprehensive safeguards agreements, additional protocol, nuclear material accountancy and control at a nuclear reactor, inspections

NUCLEAR SECURITY AT A NUCLEAR REACTOR

Basic principles of security at a nuclear reactor, basic principle of the physical protection system, its objectives, design, analysis & evaluation

PART C – HANDS-ON ACTIVITIES

RADIATION DETECTION IN PRACTICE

Basic principles of detection of various types of radiation (alpha, beta, gamma, neutrons), radioactive decay, radioisotopes half-life, three basic way how to protect from radiation - time, distance and shielding

NEUTRON DETECTION IN PRACTICE

Basic principles of neutron detection, set-up of neutron detection system, neutron detection in the core of the reactor, neutron flux distribution measurement in the core

RADIATION MONITORING IN PRACTICE

Hands-on experience with the radiation protection and radiation monitoring in the reactor hall, personnel monitoring, monitoring of dose rate in the reactor hall in various positions and at the various reactor power levels

DELAYED NEUTRONS IN PRACTICE

Role of prompt and delayed neutrons in safe reactor operation, delayed neutron detection and measurement of its characteristics, use of delayed neutrons in the detection of nuclear material in samples – measurement of U-235 content in unknown sample

OPERATION OF RESEARCH REACTOR - REACTOR PHYSIC IN PRACTICE

Relation of multiplication to reactor power, reactor in critical, subcritical and supercritical state under various conditions, reactor with and without feedback, temperature and void reactivity coefficients and their role in safe reactor operation

HANDS-ON OPERATION OF REACTOR

Practical training at the reactor operation, hands-on experience with reactor operation by all course participants, start-up of the reactor, increasing and decreasing the reactor power, safe shut-down of the reactor

NEUTRON ACTIVATION ANALYSIS IN PRACTICE

Demonstration activity with neutron activation analysis, basic principle of neutron activation analysis, use of neutron activation analysis in everyday life, sample irradiation in the reactor, analysis of the samples at detection system, determination of the composition of the samples

SAFEGUARDS IN PRACTICE

Hands-on experience with safeguards at the VR-1 reactor

NUCLEAR SECURITY IN PRACTICE

Hands-on experience with nuclear security at the VR-1 reactor, physical protection (security) laboratory, hands-on experience with physical protection systems at (security) laboratory

PART D - TECHNICAL VISITS

VR-1 RESEARCH REACTOR

Visit of the VR-1 research reactor (low power pool type reactor, 1 KW) at Czech Technical University in Prague, VR-1 reactor construction and its experimental facilities, VR-1 reactor utilization

GOLEM FUSION REACTOR

Visit of the GOLEM fusion reactor (tokamak type fusion reactor) at Czech Technical University in Prague, Department of Physics, how GOLEM works, GOLEM construction and operation, safe and secure operation of fusion reactor

NATIONAL RADIATION PROTECTION INSTITUTE

Visit of the SURO – National radiation protection institute – national system for urgent actions in the case of radiological or nuclear accidents, national regulatory body emergency centre, whole body counter, etc.

~~TEMELIN NUCLEAR POWER PLANT~~

~~Visit of the Temelin nuclear power plant (WWER-1000, PWR, 2x1000 MWe), walk through the nuclear power plant, full scope simulator, lecture on CEZ energy strategies and policy~~

Due to strict entry procedure to the Temelin NPP cause by COVID-19 Pandemic this visit will be replaced by other technical visit to Research centre Rez, to Radwaste repository, or to underground test site for final disposal of spent nuclear fuel.

SKODA NUCLEAR MACHINERY

Visit of the Skoda Nuclear machinery in Pilsen – heavy components course, reactor inner parts course and I&C course, transport and storage casks CASTOR

IAEA AND CTBTO

Visit of the International Atomic Energy Agency (IAEA) and Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO),…