Department of Nuclear & Quantum Engineering

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▣ Overview

Nuclear and Quantum Engineering is an academic field that encompasses nuclear science and technology, and quantum technology. Nuclear science and technology is primarily concerned with the peaceful use of energy generated by nuclear fission and fusion reactions whose scope includes electric power generation, desalination, district heating, hydrogen production, and propulsion of spacecrafts and vessels. The studies of quantum technology are related to the microscopic particles and their quantum phenomena and the scope of the studies includes medical imaging, quantum information and quantum computer, quantum optics, and nanotechnology.

The Department of Nuclear and Quantum Engineering has developed the new academic program that balances the existing field of nuclear engineering and the new field of quantum engineering. We aim to educate, train, and nurture those who can lead in science and technology for the 21st century.

▣ Academic Activity and Research Areas

• Nuclear Reactor Physics and Computational Particle Transport

The interests of this research field are focused on the investigations of neutron and radiation particle transport and their interactions with matter for engineering applications. The area includes studies of space-energy-time distributions of neutrons in nuclear reactors and of neutral and charged particle transport in various media, based on reactor physics, atomistic and molecular simulations and computational science. These are then applied to reactor core design, reactor control, in-core fuel management, nuclear imaging, radiation therapy planning, and radiation shielding in the design of various such nuclear systems. The research activities involve large-scale computation and simulations using high-performance parallel, distributed, and cluster computers.

• Nuclear Thermal-hydraulics and Nuclear Reactor Safety

This field covers the education of nuclear thermal-hydraulics and nuclear reactor safety, fundamental thermal-hydraulic experiments, thermal-hydraulic verification tests, and the development of software for core thermal design and safety analysis.

• Nuclear Environmental Engineering and Radioactive Waste Management

The fields of nuclear environmental engineering and radioactive waste management include the education and research on nuclear chemical engineering, radioactive management and health physics, that is, nuclear fuel cycle, radioactive waste management and disposal, performance assessment of waste disposal site, spent fuel technology and interim storage, water chemistry and isotope separation.

• Nuclear Materials

Better reliability and longer life of nuclear structural materials and fuels are sought through continuously improving fabrication and test methods. They are based on microstructure and property relationship, evaluation of fracture, fatigue, corrosion, and their synergistic effects under nuclear environments. Current research activities are concerned with microstructural change under irradiation, crack formation and propagation under stress corrosion condition, and hydrogen behavior in materials at elevated temperatures.

• Radiation Detection and Medical Imaging

Based on the knowledge of behavior of ionizing radiation in materials, research on the simulation of radiation transport, the new radiation sensor material, the radiation imaging detectors, the signal processing electronic circuits, and the image processing electronics are performed for the applications in radiation protection and dosimetry, non-destructive test and security monitoring, medical diagnostic imaging.

• Neutron Scattering and Nanoscale Materials

Neutron scattering is a very powerful technique to investigate structures and dynamics of nanoscale materials. The fundamental phenomena and technical applications of nanoscale materials such as molecular self-assembly, carbon nanotubes, nanoparticles and their self-assembled superstructures, biomembrane-protein complex, magnetic and superconducting materials are studied using neutron scattering.

• Quantum Beam Engineering

Main research in quantum beam engineering includes generation and utilization of both the photon beam and the charged-particle beams such as electron beam, proton beam, and positron beam. This field has close relations with particle accelerators and the advanced photon sources. Applications of the quantum beams to the nanotechnology, materials,

environment, biotechnology, and basic science are also studied.

• Nuclear Energy Policy

In this course, the focus is on technological comparisons, the economical and environmental analysis and the policies of various energy sources such as nuclear fission, thermonuclear fusion, solar energy and the other alternative energy sources together with key energy conversion systems.

• Engineering of Nuclear Fusion Reactor

Fundamental theories and engineering problems related to nuclear fusion reactors are studied. Educational and research topics include principle of nuclear fusion reactions, plasma behavior in fusion reactors, energy balance in fusion reactors and several other important engineering problems in fusion reactor systems.

• Nuclear Power Electronics and Robotics

We research the wireless power transfer technologies to supply electric energy to all moving things freely such as On Line Electric Vehicles (OLEV), mobile phones, and nuclear robots. We also research the nuclear electronic circuits for highly robust nuclear power instruments, magnetic bearings, and passive electro-magnetic pumps of next generation fast reactors. Moreover, we research power electronics on smart grids and renewable energies, as well as LED drivers and the power supplies for X-ray generators.