Description of Courses(Graduate Program)

NQE502 Principles and Applications of Nuclear Engineering 3:0:3(4)
This course is designed to provide the key knowledge of the nuclear engineering to the graduate students with non-nuclear background interested in nuclear engineering. For this, the fundamental principles and practical applications related to the utilization of nuclear energy from fission are introduced. The major topics included are interaction of radiation with matters including fission, types of nuclear reactors, neutron diffusion and moderation, nuclear reactor theory, heat generation and transfer, radiation protection and dose calculation, and nuclear safety.

NQE503 Radiation Science, Technology and Applications 3:0:3(4)
This course is designed to provide fundamentals of radiation science and technology to those who did not major in nuclear and/or radiological engineering in their undergraduates. The course contents include 1) interaction of radiation with matters, 2) radiation dosimetry and measurements, 3) radiation health effects and regulations, and 4) radiation applications.

NQE510 Nuclear Reactor Kinetics 3:0:3(4)
This course is designed to cover the dynamics of nuclear systems. Major subjects are : ① delayed neutrons and inhour equations, ② response to constant, step, and time-dependent reactivities, ③ mechanisms of reactivity feedbacks, ④ reactivity measurements, ⑤ reactivity stability theory etc.

NQE512 Nuclear Reactor Analysis and Design 3:0:3(4)
This course is designed to cover the nuclear reactor analysis and design, introduction of neutron transport equation, approximation of diffusion theory, solution of few-group and multi-group neutron diffusion equation, calculation of energy distribution of fast and thermal neutrons, and homogenization to heterogeneous reactors. It also include recent methods (ex. nodal method) to predict the spatial and temporal distribution of neutrons, This course includes several projects running design computer code systems under realistic reactor design situation

NQE513 Neutron/Radiation Transport Theory and Computation 3:0:3(4)
This course is designed to cover the neutron/radiation transport theory and its computation. It includes nuclear data evaluation and processing, computational methods, and numerical algorithms for continuous, one-group, multi-group neutron and radiation transport computational formulations, that can be applied to the design of various nuclear reactors, radiation shielding facilities, analysis of radiation distribution in systems such as nuclear fusion reactor, accelerator, nuclear bio-medical equipment, and nuclear imaging problems in nuclear prospecting, nuclear assay, and computed tomography.

NQE514 Monte Carlo Methods and Applications 3:0:3(4)
This course deals with fundamentals of the Monte Carlo methods: (1) random variables and random number generation, (2) sampling procedures, (3) analog Monte Carlo, (4) non-analog Monte Carlo and variance reduction techniques, and then applies the methods to a selection of representative benchmark problems from several application areas: (5) radiation particle (neutron, gamma-ray, and charged particles) transport problems, (6) eigenvalue problems, (7) multiple integrals and integral equations, and (8) optimization problems.

NQE517 Fast Reactor Design and Analysis 3:0:3(4)
This course deals with the essential principles, characteristics, and applications of the fast reactors utilizing fast neutrons. Major design characteristics of fast reactors are

studied in terms of the core design, reactor kinetics, and fuel management, safety, etc. Special attention is paid to core analysis methodologies and the passive safety characteristics.

NQE521 Reactor Thermal-Hydraulics 3:0:3(4)
The primary objective of this course is to cover the physical phenomena and models for thermal-hydraulics design and analysis of the core of a nuclear reactor including convection in the core, two-phase flow dynamics, two-phase heat transfer, and drift-flux/two-fluid models. Based on the understanding of the physical phenomena and models, we deal with fuel thermal analysis, core thermal analysis, and LOCA safety analysis related to core thermal design. Core thermal design methodology is learned based on thermal design principles.

NQE522 Nuclear Power Plant Design Project 3:0:3(4)
The objective of this course is to accumulate the composite design experiences of the core and other equipments using the principles of nuclear engineering. Unique design of reactor core satisfying the parameters of the particular reactor type, the output of power and the limit temperature, etc., the size of core and the size, the number, the interval and the operating temperature, etc. of fuel rods must be determined by computational codes. It also includes an estimate of the cost price for a reactor system containing heat exchangers, steam generators, condensers, turbines, etc.

NQE523 Nuclear Reactor Safety 3:0:3(4)
The course provides safety goals, characteristics, analysis methods and diagnosis techniques. Both deterministic and probabilistic analyses related with transients, design basis accidents and PSA level 2 and 3 are emphasized. The course covers actual plant accidents. Also, students deduct and discuss safety issues in case-studies.

NQE524 Simulation of Nuclear and Quantum System 3:0:3(4)
This course provides students with understanding of analysis methods, artificial intelligence and simulation methodologies which can be applied in nuclear and quantum engineering. Methodologies related with neutron transport, thermohydraulics, safety analysis and structural mechanics are discussed. In the artificial intelligence part, the course includes expert system, neural network, fuzzy theory, and other artificial intelligence language. Students can understand uncertainty problem and sensitivity study in computer codes.

NQE526 Quantum and Micro Energy Transport 3:0:3(4)
This course provides students with understanding of quantum and micro energy transport phenomena. This course covers the concept of energy carriers - phonon, electron and photon, and analytical methods based on molecular dynamics simulation. This course will make discussions on applied areas such as thermoelectric power generation and cooling, heat conduction and phase change in thin film, and micro measurement techniques.

NQE527 Gas-cooled Reactors and Hydrogen 3:0:3(4)
With reviewing the history of the gas-cooled reactors, the hydrogen-production gas-cooled reactors is studied. This course teaches the basic principles of Brayton cycle, nuclear fuel/core design, and safety with the introduction of the gas-cooled fast reactors. We discuss the principle of hydrogen production through electrolysis and thermochemical process. We analyze a fuel-cell/turbine cycle and the economy of the various options of the hydrogen-production gas-cooled reactors.

NQE528 Introduction to Risk and Reliability Engineering 3:0:3(4)
The main focus of the course will be on the principles and methods for assessing technological risks and reliability. The course is intended to provide a rudimentary background for those who have not been exposed to the subject. Either graduate students or upper-class undergraduates can benefit from the course. The course will emphasize the applications based on probabilistic analysis.

NQE529 Nuclear System Design Course 3:0:3(4)

Design methodologies including axiomatic design is introduced and are applied to nuclear systems. Design examples in the nuclear energy and radiation applications is introduced and how the design principles are applied to real design is explained.

NQE533 Nuclear Power Plant Instrumentation and Control Systems 3:1:3(6)
This course is designed to provide graduate and high level undergraduate students who want to understand and to have skills on analysis and design of nuclear power plant instrumentation and control systems with the knowledge on instrumentation and sensor theory, various process instrumentation and control techniques as well as many real world nuclear power plant instrumentation and control systems.

NQE535 Human Factors Engineering in Nuclear Power Plants 3:0:3(4)
Human play important roles in operation and maintenance of NPPs. It can be easily revealed by seeing that the human is nearly 50% responsible in NPP incidents and accidents. Human factors engineering in nuclear engineering is to understand human factors well and apply those knowledge to nuclear power plant design and many others. This course is developed to provide graduate students and senior undergraduate students with knowledge and theory in nuclear human factors engineering.

NQE537 Wireless Power Electronics 3:0:3(4)
Introduce the development process of the On-Line Electric Vehicles developed by KAIST as a future electric vehicle solution for oil shortage and CO2 emission problems, and newly adopt the「Mobile Power Electronics」that deals with "IT technology that changes the world" of wireless power transfer technology applied to transportations, robots, mobile information devices, and home appliances.

NQE538 Smart Grid and Power Electronics 3:0:3(4)
Smart grids as well as renewable energies such as wind power and solar power are introduced, and various converters such as rectifiers, inverters, and cyclo-converters are explained. Useful power circuit analysis methods including switching function modelling, circuit DQ transformations, and phasor transformations are introduced, and hundreds of practical applications on power electronics circuit examples are widely covered.

NQE540 Nuclear Chemical Engineering 3:0:3(4)
Overall chemical engineering process technologies and principle applicable to nuclear engineering are covered and described. Technology applied and newly developed for nuclear fuel cycle will be discussed in detail. Radioactivity and decay chain analysis method, technology or process applied to front-end fuel cycle, characteristics and analysis of nuclear spent fuels, fission products, and actinide, fundamentals of nuclear water technology and isotope separation methods are described in detail

NQE541 Nuclear Waste Management 3:0:3(4)
The course introduces fundamental principles and major issues of nuclear waste management. The coverage focuses on spent nuclear fuel and high-level waste. Modeling to describe the behavior of waste forms, packages, and the repository system, transport of radionuclides in the subsurface environment, and human risk are discussed.

NQE542 Chemistry of Actinides 3:0:3(4)
The lecture deals with fundamentals of the physical and chemical properties of actinide elements. Basic chemical reactions of actinides in aquatic systems and their essential aspects pertinent to waste disposal safety are introduced. Furthermore, actinide chemistry relevant to future nuclear fuel cycle is discussed.

NQE543 Nuclear Power Plant Water Chemistry 3:0:3(4)
This course provides basics of reactor water chemistry, chemistry control and applications, and guidelines which are of critical importance for controlling thermal corrosion of SSCs (structure, system, and components) and coolant activity level in the primary and secondary reactor coolant in nuclear power plants.

NQE545 Radiation Chemistry 3:0:3(4)

If a materials is irradiated with radiation, chemical and physical properties of the materials is changed. In this course, the chemical changes and the mechanism induced by irradiation is investigated. Also, various applications of radiation is included.

NQE551 Nuclear Reactor Metallurgy 3:0:3(4)
In this course, the mechanical properties and behaviors of structural materials in nuclear power plants are described in view of the microstructure and environment. The phase transformation and microstructure are explained and their impact on strength and properties are described. The microstructure and property changes due to welding of stainless steels are described, and later their impact on corrosion resistance are discussed. The corrosion and corrosion-related cracking phenomena in nuclear power plants are discussed in view of alloying elements and microstructure. Finally, the mechanisms of failure by fatigue and fracture of nuclear structural materials are introduced focusing on the role of microstructure.

NQE552 Integrity of Nuclear Structural Materials 3:0:3(4)
The ageing and integrity concerns on the structural materials of key components are one of the major obstacles for the safe operation and life extension of nuclear power plants. In this course, various ageing phenomena in nuclear power plants are explained in terms of operating conditions the materials are exposed. The effects of ageing on the integrity of the components are evaluated and the proper management programs for ageing are proposed and discussed. For this, the subjects like design characteristics of components, surveillance programs, inspections and non-destructive tests, structural and flaw analysis are treated. Finally, integrity issues like PTS, environmental fatigue, and are discussed as case study to help the student understand the relationship between materials ageing and structural integrity.

NQE553 Nuclear Fuel Engineering 3:0:3(4)
Nuclear fuel and cladding material behavior in nuclear reactor cores are introduced in terms of swelling, fission gas release, and creep. The irradiation and temperature effects are treated in view of theory and experiment, Nuclear fuel design, fabrication, performance assessment models, reliability analysis, and recent trends of nuclear fuel materials are explained.

NQE555 Mechanics of Irradiated Materials 3:0:3(4)
Throughout this course, the students will study about the fundamentals of dislocations and diffusion, the most important factors for the mechanical behavior of solid materials. Then, it will be covered how irradiation can affect their behavior and mechanical properties. The recent experimental and computational techniques to investigate the influence of irradiation on mechanical properties will also be introduced.

NQE561 Radiation Measurement Systems 3:0:3(4)
This course introduces the generation, amplification, transfer and measurement of the electronic signal from various radiation detectors based on the physics theory of the electronic signal and noise. Also it deals with the design methods of radiation counting, spectroscopy, timing and imaging system.

NQE562 Radiation Imaging Instrumentation 3:0:3(4)
This course deals with the analysis and design methods of various radiation imaging devices used in medical diagnostics and non-destructive tests. It also covers the 2-dimensional x-ray radiography and advanced gamma-ray images together with emission and transmission tomographies and laminography, which can be extended into 3-dimensional imaging techniques.

NQE563 Radiation Biology 3:0:3(4)
This course covers the effects of ionizing radiation at the molecular, cellular, organ and organism levels with emphasis on mammalian systems, including cellular concepts, major organ systems, transuranics, nuclear war, radiotherapy and cancer in experimental animal and human exposure groups.

NQE564 Physics of Medical Imaging 3:0:3(4)

This is an introductory course at graduate level to the basic elements of various medical imaging modalities such as radiography, magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT), positron emission tomography (PET), computed tomography (CT), and ultrasound imaging. Although focus of the lectures will be upon mastering fundamentals of the imaging physics, cutting-edge issues will also be discussed to stimulate graduate research in the related areas.

NQE571 NMR Engineering 3:1:3(6)
This course introduces the basic theory of nuclear magnetic resonance (NMR) phenomena, NMR imaging techniques, NMR spectroscopy techniques and related equipment. In addition to the basic principles of NMR techniques, some examples of NMR applications in biomedical research, nanoporous materials and NMR quantum computations are discussed and some basic NMR experiments related to lectures are performed.

NQE572 Neutron Nano-Characterization 3:0:3(4)
Neutron scattering is a very powerful technique to measure atomic & nano-scale structures and dynamics of condensed matter including nano-materials, bio-materials, magnetic materials, and so on. In this class, we will discuss the basic concepts of neutron scattering and various neutron scattering techniques such as small-angle neutron scattering, reflectometry, triple-axis spectroscopy, and neutron spin-echo spectroscopy. Based on these, representative examples of neutron scattering in nano-materials will be introduced.

NQE575 Nuclear Energy Policy 3:0:3(4)
Historical development and utilization of Nuclear Energy are reviewed from the dawn of atomic age. This important alternative energy technology is evaluated comparatively in terms of techno-economic, socio-political and environmental aspects of nuclear energy uses. The nuclear energy utilization programs of major countries, regional or global basis are assessed for the characterization of different nuclear energy policy. In view of the established international nonproliferation regime and International Atomic Energy Agency (IAEA), the prospect of Nuclear Energy Policy Alternatives should be analysed in conformity with changing policy issues.

NQE581 Nuclear Fusion Engineering 3:0:3(4)
This course deals with principles and design of nuclear fusion systems. It contains the basics of nuclear fusion, fusion reactor analysis, experiments for inertial capture and magnetics, plasma heating, economic and environmental problems, and so on. It also covers the case study of nuclear plasma fusion system designs.

NQE582 Applied Plasma Engineering 3:0:3(4)
This course deals with the methodologies of several plasma generations. For this, it contains the basic principles of low-temperature plasmas and etc. And it studies several cases of industrial applications of plasma.

NQE583 Engineering of Charged Particle Beams 3:0:3(4)
This course will give fundamental physics and applications of charged particle beams such as electron beam and ion beam. The topics of the course include generation methods of charged particle beams, beam optics in electromagnetic fields, measurement of charged particle beams, and interaction of charged particles with matters.

NQE584 Radiation Protection and Regulations 3:0:3(4)
This course is designed to provide knowledge for safety regulation including evaluation and inspection on four major parts of radiation protection, radiation safety regulations, environmental radiation/radioactivity safety, and safety & security of radiation sources. Every lecture focuses on the regulatory experience, international regulatory information and trends, and up-to-date technologies of safety regulations.

NQE585 Introduction to Nuclear Safety Regulation 3:0:3(4)
This course is designed to introduce nuclear safety regulation, which will be a basis of

consecutive advanced courses on installation safety regulation and radiation safety management. Major subjects include: Concept of Safety Regulation, Legal and Organizational Infrastructure, Safety Culture, Licensing Process, Safety Review and Inspection, Quality Assurance, Regulatory Effectiveness and Prospects on Future Regulatory System.

NQE586 Safety Regulation for Nuclear Installations 3:0:3(4)
This course is designed to provide the appropriate knowledge specifically needed for actual regulation of safety review and inspection, and involves the following four disciplines: Safety Evaluation, Structures & Site Evaluation, Mechanical and Material Engineering, and I&C and Electrical Power Engineering. Every lecture includes the regulatory experience for the NPPs, international regulatory and trends, and up-to-date technologies of nuclear safety regulations.

NQE587 Regulation for Nuclear Fuel Cycle and Emergency Preparedness 3:0:3(4)
This course is designed to provide knowledge for safety regulation including evaluation and inspection on major parts of (front & back end) fuel cycle, and nuclear/radiological emergency preparedness. Every lecture focuses on the regulatory experience, international regulatory information and trends, and up-to-date technologies of safety regulations.

NQE588 Advanced Design Project 1 for Nuclear and Quantum Engineering 0:9:3
This class is offered for the students in Renaissance Ph.D. program and the students who are interested in the system design. At the beginning of the semester, projects is given to the students and the results are evaluated at the end of the semester. Object systems are nuclear energy systems and radiation application systems (for medical, science, etc.)

NQE589 Advanced Design Project 2 for Nuclear and Quantum Engineering 0:9:3
This class is offered for the students in Renaissance Ph.D. program and the students who are interested in the system design. At the beginning of the semester, projects is given to the students and the results are evaluated at the end of the semester. Object systems are nuclear energy systems and radiation application systems (for medical, science, etc.)

NQE595 Technical Writing in Nuclear and Quantum Engineering 3:0:3(4)
Writing a technical paper for publication in English. The course presents the requirements for publishing in a professional journal in nuclear and quantum engineering. Each student will write preliminary documents and a final paper for real or imaginary publication. Class-work time will be directed among pair and group work, peer evaluation and teacher interaction. The final paper will be orally presented to the class in a format similar to a professional meeting.

NQE597 Special Topics in Nuclear and Quantum Engineering Ⅲ 1:0:1(4)
Course covers the special field of nuclear and quantum engineering which is not covered by the given courses. The content can be variable and will be chosen by the instructor.

NQE598 Special Topics in Nuclear and Quantum Engineering Ⅰ 2:0:2(4)
Course covers the special field of nuclear and quantum engineering which is not covered by the given courses. The content can be variable and will be chosen by the instructor.

NQE599 Special Topics in Nuclear and Quantum Engineering Ⅱ 3:0:3(4)
Course covers the special field of nuclear and quantum engineering which is not covered by the given courses. The content can be variable and will be chosen by the instructor.

NQE625 Computational Analysis in Nuclear System 3:0:3(4)
This course is designed for graduate student level who are interested in designing and performing safety analysis of existing nuclear power plants and the next generation nuclear power plants. The course will try to make the students understand basic 1D Thermal Hydraulics code and 3D CFD code for nuclear component analyses.

NQE628 Application of Probabilistic Safety Assessment 3:0:3(4)
The course provides an introduction to the fundamentals of plant risk assessment and the

new issues of probabilistic risk assessment. Methods of risk model development and their quantification with software tools are included. The topics of the course cover plant risk model, its uncertainty analysis, and recently emerging technical issues such as passive system risk assessment, human reliability, digitalized plant risk assessment, software reliability assessment, and automatic diagnostic features.

NQE631 Nuclear and Quantum Instrumentation and Control Design. 2:3:3(6)
This course is designed to provide graduate students who want to understand and get skills for designing nuclear and quantum I&C systems with detailed analysis skills of subsystems, system integration methods, and pertinent theory and technology. (prerequisite subject : NQE532)

NQE654 Materials for Nuclear Fuel Cycle 3:0:3(4)
This course is designed to provide an overview of functional materials for nuclear applications and to introduce the key materials for nuclear fuel cycle. The course includes basic materials science of uranium, plutonium, thorium, functional materials for nuclear power reactor, spent fuel storage and waste management.

NQE656 Advanced Nuclear Systems and Materials 2:3:3(6)
In this course, the materials and environments of the generation-IV reactors and fusion reactors, and the key material issues under active research. The properties and strengthening mechanisms of ferritic martensitic steels and nickel-base superalloys are explained in view of those high temperature nuclear environments. The materials degradation in various environments such as, liquid-metal, super-critical water, super-critical CO2, high temperature helium, and so on, are described. Finally, the impact of the surface damage to high temperature properties are discussed. To encourage the participation of students, students' seminar on selected topics are included as well as lectures.

NQE675 Nuclear Nonproliferation, Safeguards, and Security 3:0:3(4)
This course will introduce students to policy issues and technologies for peaceful uses of nuclear energy, and cover analytical techniques used for quantification and characterization of nuclear and radioactive materials for safeguards in nuclear facilities and forensics in nuclear crime scene.

NQE726 Special Topics in Nuclear Safety Analysis 2:3:3:(6)
Discussion on numerical and physical models of computer codes developed for nuclear safety analysis. Emphasis on development of mathematical and numerical models, and solution techniques, of two-phase flow. Treatment of physical models of separated flow such as flow-regime map, wall friction and heat transfer, interfacial friction and heat transfer, bifurcation phenomena. Development of a simple two-phase code and performance of class practice for various events.

NQE960 M.S. Thesis Research

NQE965 M.S. Independent Research

NQE980 Ph.D. Thesis Research

NQE966 Seminar(M.S.) NQE986 Seminar(Ph.D.) 1:0:1
Seminar is given by the staff of the department or invited guest speaker on topics of recent interest in the overall field of nuclear engineering, including the design and operation of nuclear reactors, reactor kinetics, heat transfer, energy conversion, radiation shielding, nuclear fuel cycle and management, nuclear materials and safety, and radiation technology etc.