Department of Nuclear Engineering

Nuclear Engineering [NUE]

Department of Nuclear Engineering includes the advancement of safety measures in operating nuclear power plants, the development of fourth generation (Gen-IV) reactors including ultra-long cycle fast reactor (UCFR), small and medium-sized nuclear reactors. For these, the research is focused into nuclear fuel design (metallic fuel, coated fuel, ceramic fuel, and fuel cycle), reactor design including neutron transport and diffusion, and reactor core simulator, cladding and structural materials in advanced nuclear energy systems, design of advanced nuclear systems, nuclear safety systems and engineered features, advanced liquid metal transportation for fast reactors and nuclear fusion reactors, advanced nuclear radiation protection and detections, nanofluids and nanocomposites for advanced nuclear coolants and nuclear fuel. Furthermore, included are UniST Advanced Research Reactor (USTAR), avanced safety systems and molten core cooling systems for I-Power reactor, spent fuel storage, liquid metal MHD generation, accelerator physics, neutron science, nuclear data, and fundamentals of nuclear fusion for the future energy development.

Credit Requirement

Program	Total Credits required	Course Credit	Research Credit
Master's Program	at least 28 credits	at least 18 credits	at least 10 credits
Doctoral Program	at least 60 credits	at least 24 credits	at least 36 credits
Combined Master's-Doctoral Program	at least 60 credits	at least 33 credits	at least 27 credits

Curriculum

▶ Nuclear Engineering [NUE]

Course is	Course No.	Classification	Course Title	Course Title (Kor.)	Cred.-Lect.-Exp.	Pre-requisite	Convergence
Required	NUE590	Research	The Seminars	세미나	1-1-0		
	NUE600	Lecture	Research Trends in Nuclear Engineering I	원자력공학 연구 동향 I	3-3-0		
	NUE690	Research	Master's Research	석사논문연구	Value of Credit		
	NUE890		Doctoral Research	박사논문연구	Value of Credit		
Elective	NUE501	Lecture	Structural Mechanics in Energy Systems	에너지 시스템 구조 역학	3-3-0		O
	NUE502		Engineering of Nuclear Energy System	원자력 시스템 공학 특론	3-3-0		
	NUE503		Special Topics in Structural Materials in Energy Systems	에너지 구조 재료 공학 특론	3-3-0		
	NUE504		Advanced Energy Conversion	에너지 변환 공학 특론	3-3-0		
	NUE505		Modeling and Simulation in Energy System	에너지 전산 모사	3-3-0		
	NUE507		Nuclear Reactor Dynamics	원자로 동력학	3-3-0		
	NUE510		Nuclear Reactor Core Design and Engineering	원자로심설계공학	3-3-0		
	NUE511		Nuclear Fuel Engineering	핵연료 공학	3-3-0		
	NUE512		Radiation Measurement System Ⅰ	방사선계측 Ⅰ	3-3-0		
	NUE513		Nuclear Reactor Core Analysis Ⅰ	원자로심해석 Ⅰ	3-3-0		
	NUE514		Nuclear Reactor Core Analysis II	원자로심해석 II	3-3-0		
	NUE515		Liquid Metal Magnetohydrodynamics I	액체금속 자기유체역학 I	3-3-0		
	NUE516		Nuclear Fuel Design and Performance Analysis	핵연료설계 및 성능 분석	3-3-0		O
	NUE517		Nuclear Reactor Theory	원자로 이론	3-3-0		
	NUE519		Nuclear Safety	원자력 안전	3-3-0		
	NUE520		Nuclear Safety System Design and Lab	원전안전계통 설계실습	3-3-0		

Course is	Course No.	Classifi cation	Course Title	Course Title (Kor.)	Cred.-Lect.-Exp.	Pre-requisite	Conver gence
Elective	NUE521	Lecture	Liquid Metal Magnetohydrodynamics II	액체금속 자기유체역학 II	3-3-0		
	NUE522		Special Topics on Advanced Nuclear Design Engineering	첨단 원자력 설계 공학 특론	3-3-0		O
	NUE523		Nuclear Safety and Convergence Technology	원자력 안전 및 융합 기술	3-3-0		O
	NUE524		Radiation Measurement System II	방사선 계측 II	3-3-0		
	NUE525		Spent Nuclear Fuel Engineering	사용후핵연료공학	3-3-0		
	NUE527		Nuclear Material Safeguards and Non-Proliferation	핵물질 안전조치와 핵비확산	3-3-0		
	NUE528		Nuclear Fuel Performance Experiment and Modeling	핵연료성능 실험 및 모델링	3-3-0		
	NUE529		Radiation Materials Engineering I	방사선재료공학 I	3-3-0		
	NUE530		Radiation Materials Engineering II	방사선재료공학 II	3-3-0	NUE529	
	NUE531		Probabilistic Safety Assessment	확률론적안전성평가	3-3-0		
	NUE532		Application of Probabilistic Safety Assessment	확률론적안전성평가 응용	3-3-0	NUE531	
	NUE533		Nuclear Safety Policy	원자력 안전정책	3-3-0		
	NUE619		Special topics in Nuclear Engineering I	원자력공학특론 I	3-3-0		
	NUE629		Special topics in Nuclear Engineering II	원자력공학특론 II	3-3-0		
	NUE639		Special topics in Nuclear Engineering Ⅲ	원자력공학특론 Ⅲ	3-3-0		
	NUE649		Special Topics in Nuclear Engineering Ⅵ	원자력공학특론 Ⅵ	3-3-0		
	NUE659		Special Topics in Nuclear Engineering Ⅶ	원자력공학특론 Ⅶ	3-3-0		
Elective (Ph.D.)	NUE719		Special topics in Nuclear Engineering Ⅳ	원자력공학특론 Ⅳ	3-3-0		
	NUE729		Special topics in Nuclear Engineering Ⅴ	원자력공학특론 Ⅴ	3-3-0		
Elective	NUE790	Research	Research Trends in Nuclear Energy II	원자력공학 연구 동향 II	2-2-0		

Description

NUE501 Structural Mechanics in Energy Systems [에너지 시스템 구조 역학]

Structural components in energy systems, their functional purposes, operating conditions, and mechanical/structural design requirements. Combines mechanics techniques with models of material behavior to determine adequacy of component design. Considerations include mechanical loading, brittle fracture, inelastic behavior, elevated temperatures, neutron irradiation, vibrations and seismic effects.

NUE502 Engineering of Nuclear Energy System [원자력 시스템 공학 특론]

This course covers the advanced topics in engineering principles of nuclear reactors, emphasizing power reactors. Specific topics include power plant thermodynamics, reactor heat generation and removal (single-phase as well as two-phase coolant flow and heat transfer). It also discusses engineering considerations in reactor design.

NUE503 Special Topics in Structural Materials in Energy Systems [에너지 구조 재료 공학 특론]

Applies thermodynamics and kinetics of electrode reactions to aqueous corrosion of metals and alloys. Application of advanced computational and modeling techniques to evaluation of materials selection and susceptibility of metal/alloy systems to environmental degradation in aqueous systems. Discusses materials degradation problems in various energy system including nuclear.

NUE504 Advanced Energy Conversion [에너지 변환 공학 특론]

Introduces basic background, terminology, and fundamentals of energy conversion. Discusses current and emerging technologies for production of thermal, mechanical, and electrical energy. Topics include fossil and nuclear fuels, solar energy, wind turbines, fuel and solar cells.

NUE505 Modeling and Simulation in Energy System [에너지 전산 모사]

Concepts of computer modeling and simulation in materials science and engineering. Uses techniques and software for simulation, data analysis and visualization. Continuum, mesoscale, atomistic and quantum methods used to study fundamental and applied problems in physics, chemistry, materials science, mechanics, engineering, and biology. Examples drawn from the disciplines above are used to understand or characterize complex structures and materials, and complement experimental observations.

NUE507 Reactor Dynamics [원자로 동역학]

This course covers the time-dependent behaviour of nuclear reactors and the under-lying governing equations and their mathematical solutions. The delayed neutron, which makes nuclear reactor controllable, is investigated and derivation, validity, and solution of the point reactor equation are studied. Principles of the reactivity measurement and the reactivity feedback effects are also investigated. In addition, the general space-time-dependent reactor dynamics is studied.

NUE510 Nuclear Reactor Core Design and Engineering [원자로심설계공학]

The purpose of this course "Nuclear Reactor Core Design and Engineering" is to provide students with basic insight into nuclear reactor core design and engineering for use of nuclear energy as a safe and economical energy source. This course is designed to study nuclear fuel, nuclear design, thermal/hydraulic design, safety analysis, and nuclear fuel cycle economics. This course will also cover special topics such as reactor core design criteria, core design requirements, core design procedure, technical specifications, and nuclear power plant licensing.

NUE511 Nuclear Fuel Engineering [핵연료 공학]

This course covers the materials and structure, characteristics and basic in-reactor performance of the fuels used in PWR, BWR, CANDU, fast reactors, research reactor and small and medium size reactors. It will also introduce, for PWR UO2 fuel, the basic requirements, fuel safety and design criteria, the basics of fuel rod design and fuel assembly design, important fuel performance modelling. It will also cover the basics of the design/analysis computer codes which are used in PWR UO2 fuel design. Finally fuel fabrication processes of the PWR UO2 fuel will be introduced.

NUE512 Radiation Measurement Systems I [방사선 계측 I]

This course covers the principle of the radiation instruments. It deals with the counting and measurement mechanism for the ionizing radiation such as alpha, beta, gamma and neutron. It introduces radiation spectrometry, radioactivity analysis, calibration, measurement statistics including measurement uncertainty.

NUE513 Nuclear Reactor Core Analysis I [원자로심해석 I]

This class will study computational methods for nuclear engineering applications. Focus will be on the theory behind numerical methods for solving the partial differential equations encountered in nuclear reactor analysis. We will investigate various spatial discretization techniques, as well as the methods used to solve large, sparse systems of linear and nonlinear equations. Lectures will cover the various conservation laws for mass, energy, and momentum and the methods used to discretize the applicable elliptical and parabolic equations. Linear solution methods will include direct, iterative (e.g. SOR, etc.), and semi-iterative (e.g. Krylov, etc.) techniques, with special attention given to methods that lend themselves to high performance computing. Newton-Krylov methods will be introduced for solving nonlinear systems of equations.

NUE514 Nuclear Reactor Core Analysis II [원자로심해석 II]

This class will study computational methods for nuclear engineering applications. Focus will be on the theory behind numerical methods for solving the partial differential equations encountered in nuclear reactor analysis. We will investigate various spatial discretization techniques, as well as the methods used to solve large, sparse systems of linear and nonlinear equations. Lectures will cover the various conservation laws for mass, energy, and momentum and the methods used to discretize the applicable elliptical and parabolic equations. Linear solution methods will include direct, iterative (e.g.

SOR, etc.), and semi-iterative (e.g. Krylov, etc.) techniques, with special attention given to methods that lend themselves to high performance computing. Newton-Krylov methods will be introduced for solving nonlinear systems of equations.

NUE515 Liquid Metal Magnetohydrodynamics I [액체금속 자기유체역학 I]

This course covers the magnetohydrodynamic (MHD) characteristic of the liquid metal used in fast reactor, nuclear fusion reactor and accelerator. Instructor will include Lorents' force produced in the liquid metal with the high electrical conductivity such as sodium, gallium, lead and mercury, flow characteristic, pressure drop under the magnetic field. The students will study the property of the electromagnetic pump for the liquid metal transportation and the liquid metal MHD electricity generation system.

NUE516 Nuclear Fuel Design and Performance Analysis [핵연료설계 및 성능 분석]

This course intends to provide the students with practical knowledge and experience for the design and analysis of the LWR UO2 fuel. It will first discuss the backgrounds and the derivation of the fuel safety and design criteria, design and analysis method, and licensing requirements for LWR UO2 fuel. The design models and actual measurement data on irradiation performances of the important in-reactor fuel performances, which includes fission gas release, densification and swelling, restructuring, fuel thermal conductivity change during irradiation, high burnup effects, cladding corrosion, cladding creep, pellet-cladding interaction, etc. will be discussed and compared. Practical examples of fuel rod design and fuel assembly design will be introduced and the practices with fuel design/analysis computer codes will be given.

NUE517 Nuclear Reactor Theory [원자로 이론]

The understanding of neutron behaviour in the nuclear reactor is very important for the design of new nuclear reactors and the safe operation of existing nuclear reactors. This course covers methodologies of neutron flux calculations, diffusion and slowing down theory, flux separation, material buckling, resonance absorption, Doppler effect, 2-group and multi-group theories, and reactivity balances for design and operation. There will be an introduction to reactor kinetics, delayed neutrons, point reactor kinetics, transient behavior, load changes, reactivity feedback, and safety implications.

NUE519 Nuclear Safety [원자력 안전]

The purpose of nuclear safety is to prevent the release of radioactive materials during events and accidents. This course covers the actions taken to prevent nuclear and radiation accidents or to limit their consequences. To date, there have been five serious accidents (core damage) in the world since 1970 (one at Three Mile Island in 1979; one at Chernobyl in 1986; and three at Fukushima-Daiichi in 2011), corresponding to the beginning of the operation of generation II reactors. Based on experiences of the accidents, the course discuss the safety culture as one relatively prevalent notion about nuclear safety.

NUE520 Nuclear Safety System Design and Lab [원전 안전 계통 설계실습]

This course covers the principles of design of the nuclear safety systems. The three primary objectives of nuclear reactor safety systems are to shut down the reactor, maintain it in a shutdown condition, and prevent the release of radioactive material during events and accidents. These objectives are accomplished using a variety of equipment, which is part of different systems, of which each performs specific functions. The students will participate in field-oriented design and practice programs.

NUE521 Liquid Metal Magnetohydrodynamics II [액체금속 자기유체역학 II]

This course is focused on the unbounded flow known as Rayleigh-Stokes flow, flow transition and magnetohydrodynamic (MHD) stability, which is characterized by a control parameter such as Reynolds or Rayleigh number and Hartman number, of the liquid metal flow in the externally-driven magnetic field. MHD turbulent flow is approached mathematically by using mean field theory and its local property is discussed for the different orientation of geometry, direction of magnetic field, and velocity. Also, the attention is focused on the solution of simple examples of magnetoconvective flows.

NUE522 Special Topics on Advanced Nuclear Design Engineering [첨단 원자력 설계 공학 특론]

This course will cover various aspects of nuclear reactor design: nuclear reactor core design including neutronics and thermal-hydraulics, spent fuel analysis, fuel cycle, and fast spectrum reactor system analysis as well as thermal system. Students will study the reactor design concepts and practice the design procedures using computer codes.

NUE523 Nuclear Safety and Convergence Technology [원자력 안전 및 융합 기술]

Safety feature of a nuclear reactor that does not require operator actions or electronic feedback in order to shut down safely in the event of a particular type of emergency (usually overheating resulting from a loss of coolant or loss of coolant flow) can be advanced using convergence technology, e.g. nuclear and nano-technologies and nuclear and ICT. After the Fukushima accidents, the multi-physics concepts based on thermal-hydraulics and materials sciences are becoming key factors to enhance nuclear safety. The area can be coupled by Information technology. The course will cover the multiphysics-based safety principles and introduce convergence technologies in recent trends.

NUE524 Radiation Measurement Systems II [방사선 계측 II]

This course covers the principle of the radiation instruments. It deals with the counting and measurement mechanism for the ionizing radiation such as alpha, beta, gamma and neutron. It introduces radiation spectrometry, radioactivity analysis, calibration, measurement statistics including measurement uncertainty.

NUE525 Spent Nuclear Fuel Engineering [사용후핵연료공학]

This course covers fundamentals, practices, and issues of spent nuclear fuel management from in-core behavior, on-site pools, interim storages, transportation, partitioning, transmutation, and disposal. Among these topics, major focus will be given for partitioning, transmutation, and disposal. Through this course, students will be prepared to research one of the most difficult challenges we are facing in nuclear power based on solid understanding.

NUE526 Chemistry of Actinide and Fission Product [악티나이트화학]

This course covers thermodynamics and kinetics of actinide and fission products in chemical and electrochemical reactions. In particular, lanthanide in fission products is a major element group from nuclear fission based on the double hump curve of fission yield. Actinide such as U, Pu, Am, Cm, Th and lanthanide such as La, Ce, Nd, Eu have similar characteristics because their valence shell electrons are being added to f orbitals. However, they need to be separated each other for recycling since some lanthanide isotopes are strong neutron absorbers. Students will learn how to separate actinide from lanthanide in a proliferation-resistant way.

NUE527 Nuclear Material Safeguards and Non-Proliferation [핵물질 안전조치와 핵비확산]

This course aims to thoroughly cover the fundamental aspects of nuclear material safeguards and non-proliferation for graduate students seeking professional career in these fields. Specific contents and topics of this course include the following: fundamental components of fuel cycle; histories of nuclear weapon development, IAEA, and NPT, measurement systems for Nuclear Material Accountancy (NMA), basis for material protection, control, and accounting systems, political and technological issues of nuclear proliferation, Proliferation Resistance (PR) of nuclear fuel cycle, safeguards system, Containment and Surveillance (C/S), and Physical Protection (PP).

NUE528 Nuclear Fuel Performance Experiments and Modeling [핵연료 성능 실험 및 모델링]

This course introduces experimental methodologies and underlying scientific principles commonly utilized for nuclear fuel research. The metallurgical and thermophysical characterization of radioactive materials such as uranium and thorium is essential to model and predict nuclear fuel performance. However, still wide empty space exists in the material property database due to unavoidable hardship associating with the kind of experiments. Systematic approach for specimen preparation is also seldom found in open literatures. This subject will provide an initial breakthrough for beginning nuclear fuel engineers.

NUE529 Radiation Materials Engineering I [방사선 재료 공학 I]

This course provides basic theoretical understanding on radiation interactions with materials; such as, radiation damage event, atom displacement, damage cascade, point defect formation and diffusion, defect reaction rate theory. Material degradation under extreme radiation environment, such as inside nuclear reactor core, has significant impacts on nuclear materials performance and life expectancy, however the development of this particular branch of materials science and engineering started less than a century ago. Hence, current theoretical approaches are often incomprehensive. This course will cover up-to-date experimental and theoretical approaches have been made on the issues and a renowned simulation program, Stopping and Range of Ions in Matter (SRIM).

NUE530 Radiation Materials Engineering II [방사선 재료 공학 II]

This course covers physical and mechanical effects of radiation damage, such as, radiation-induced segregation, irradiation-induced voids and bubbles, phase stability under irradiation, irradiation hardening/creep/growth. Ion beam irradiation, a cost- and time-effective experimental method frequently utilized for expedited simulation of radiation damage, will also be introduced with interrelated usage of SRIM simulation which is an essential supplementary tool for data analysis.

NUE531 Probabilistic Safety Assessment [확률론적안전성평가]

This course provides the fundamentals of probabilistic safety assessment (PSA) for quantitative evaluation of a nuclear power plant safety. This course will cover the topics for PSA such as modelling methods and tools, reliability data, common cause failures, and quantification result analysis. In addition, students will get skilled to develop a PSA model through review of a nuclear power plant PSA model and a term project.

NUE532 Application of Probabilistic Safety Assessment [확률론적안전성평가 응용]

This course covers emerging issues and applications of probabilistic safety assessment. Methods of risk model development and their quantification with software tools are included. Students will develop probabilistic safety assessment models for various initiating events and quantify the risk.

NUE533 Nuclear Safety Policy [원자력 안전정책]

This course is designed to investigate various policy issues and legislative direction on nuclear safety, provide discussions with other students, researchers, and professors. Through this course, the students will have opportunities to extend his/her knowledge in the future direction of nuclear energy safety research. In accordance with the policy on energy conversion, this course covers to study nuclear safety enhancement through free and in-depth discussions and exchange their ideas on various policy issues and legislative direction on nuclear safety.

NUE590 The Seminars [세미나]

The purpose of this course is to extend knowledge to the state-of-the-art R&D in real scientific fields; and to get indirect experience by contacting experts in various fields. Students and professors can exchange their own ideas and information to reach creative and fine-tuned achievements through the Seminars.

NUE600 Research Trends in Nuclear Engineering I [원자력공학 연구동향 I]

This course is designed to investigate recent trends in Nuclear energy fields and provide discussions with other students, researchers, and professors.

NUE619 Special topics in Nuclear Engineering I [원자력공학특론 I]

This course covers the special field of nuclear engineering such as nuclear battery, nuclear propulsion and space applications which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE629 Special topics in Nuclear Engineering II [원자력공학특론 II]

This course covers the special field of nuclear engineering such as nuclear safety, probabilistic safety assessment and creative nuclear research reactor which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE639 Special topics in Nuclear Engineering III [원자력공학특론 III]

This course covers the special field of nuclear engineering such as nuclear safety, probabilistic safety assessment and creative nuclear research reactor which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE649 Special topics in Nuclear Engineering VI [원자력공학특론 VI]

This course covers the special field of nuclear engineering such as nuclear safety, probabilistic safety assessment and creative nuclear research reactor which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE659 Special topics in Nuclear Engineering VII [원자력공학특론 VII]

This course covers the special field of nuclear engineering such as nuclear safety, probabilistic safety assessment and creative nuclear research reactor which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE690 Master's Research [석사논문연구]

This course is related with the students graduate thesis and dissertation. As such, students should be actively working in a laboratory setting and gaining experience through hands-on experimentation.

NUE719 Special topics in Nuclear Engineering IV [원자력공학특론 IV]

This course covers the special field of nuclear engineering such as nuclear fuel cycle, radiation safety, radioactive waste, decontamination and dismantling which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE729 Special topics in Nuclear Engineering V [원자력공학특론 V]

This course covers the special field of nuclear engineering such as nuclear fuel cycle, radiation safety, radioactive waste, decontamination and dismantling which are not covered by the given courses. The content can be variable and will be chosen by the instructor.

NUE790 Research Trends in Nuclear Engineering II [원자력공학 연구동향 II]

This course is designed to investigate recent trends in Nuclear energy fields and provide discussions with other students, researchers, and professors. Through this course, the students will have opportunities to extend his/her knowledge in Nuclear energy fields. Also students and professors can exchange their own ideas.

NUE890 Doctoral Research [박사논문연구]

This course is related with the students graduate thesis and dissertation. As such, students should be actively working in a laboratory setting and gaining experience through hands-on experimentation