

SCHOOL OF NUCLEAR SCIENCE AND ENGINEERING

The School of Nuclear Science and Engineering provides world-class education so students can become industry, academic, and policy leaders driving the future of nuclear science worldwide.

The School offers BS, MEng, MS, and PhD degrees in Nuclear Engineering as well as BS, MHP, MS, and PhD degrees in Radiation Health Physics. A premedical option is available for those seeking a BS in Radiation Health Physics.

World-class facilities are utilized as a part of students' education to further gain an understanding on relevant nuclear engineering and radiation health physics subject matters. These facilities reside within the Radiation Center Building on the Oregon State University campus and comprise a 1 MW_{th} TRIGA Reactor, the Advanced Thermal Hydraulic Laboratory, the Advanced Nuclear Science and Engineering Laboratory, Advanced Nuclear Instrumentation Development Laboratory, and a Radiological Research Laboratory. Instruction is integrated with an extensive research program and opportunities to participate at both the undergraduate and graduate levels.

The goals of the nuclear engineering and radiation health physics undergraduate curricula are to prepare students for careers related to the many beneficial uses of nuclear technology and energy. Nuclear engineers apply scientific principles to the research, design, and operation of a wide variety of nuclear technology applications including power generation, medicine, and radioactive waste management. Radiation health physicists study methods used to protect people and their environment from radiation hazards while enabling the beneficial uses of radiation and radioactive materials. In addition, an emphasis is provided in nuclear instrumentation, nuclear systems and materials, radiation protection, reactor analysis and nuclear power economics and, particularly, safety and regulation in nuclear operations.

Undergraduate Programs

Majors

- Nuclear Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/nuclear-engineering-bs-hbs/>)
- Radiation Health Physics (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/radiation-health-physics-bs-hbs/>)

Option:

- *Radiation Health Physics—Pre Med*

Minors

- Nuclear Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/nuclear-engineering-minor/>)
- Radiation Health Physics (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/radiation-health-physics-minor/>)

Graduate Programs

Majors

- Medical Physics (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/medical-physics-mmp-ms-phd/>)
- Nuclear Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/nuclear-engineering-meng-ms-phd/>)
- Radiation Health Physics (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/radiation-health-physics-mhp-ms-phd/>)

Minors

- Nuclear Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/nuclear-engineering-graduate-minor/>)
- Radiation Health Physics (<http://catalog.oregonstate.edu/college-departments/engineering/school-nuclear-science-engineering/radiation-health-physics-graduate-minor/>)

Brian G. Woods, School Head

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Faculty

Professors Hamby, Higginbotham¹, Higley¹, Marcum, Meyer, T. Palmer, Paulenova, Woods, Wu

Associate Professors Farsoni, C. Palmer, Reese¹, Yang

Assistant Professors Briggs, Chen, Gutowska, Mignot

Instructors Crilly, Keller, Kishore, Laub, Merz, Pillai, Ranjbar, Schickler, Tanyi, Zhang

Emeriti Binney^{1,2}, Klein², Ringle, Reyes², Robinson²

1

Certified Health Physicist

2

Licensed Professional Engineer

NSE 114, INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS I, 3 Credits

Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection.

Equivalent to: NE 114, RHP 114

NSE 115, INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS II, 3 Credits

Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection.

Equivalent to: NE 115, RHP 115

NSE 233, MATHEMATICAL METHODS FOR NSE, 3 Credits

Development and application of analytical and numerical methods with applications to problems in the NE/RHP field. Major topics will include solution of ODEs and systems of ODEs, root finding techniques and numerical integration and differentiation. Major applications will include solution of the Bateman Equations and solution of the diffusion equation.

Prerequisite: MTH 256 with C or better or MTH 256H with C or better

NSE 234, NUCLEAR AND RADIATION PHYSICS I, 3 Credits

Relativistic dynamics; basic nuclear physics; basic quantum mechanics; radioactivity; electromagnetic waves; interaction of ionizing radiation with matter; cross sections; basic atomic structure.

Prerequisite: MTH 251 with C or better or MTH 251H with C or better

Equivalent to: NE 234, RHP 234

NSE 235, NUCLEAR AND RADIATION PHYSICS II, 3 Credits

Radioactivity; radioactive decay modes; decay kinetics, interaction of neutrons with matter; nuclear reactions; fission and fusion basics; cross sections.

Prerequisite: (NSE 234 with C or better or NE 234 with C or better or RHP 234 with C or better) and (MTH 252 [C] or MTH 252H [C])

Equivalent to: NE 235, RHP 235

NSE 236, NUCLEAR RADIATION DETECTION AND INSTRUMENTATION, 4 Credits

Principles and mechanisms underlying nuclear radiation detection and measurements; operation of nuclear electronic laboratory instrumentation; application of gas-filled, scintillation and semiconductor laboratory detectors for measurement of alpha, beta, gamma, and neutron radiation; experimental investigation of interactions of radiation with matter. Lec/Lab.

Prerequisite: NSE 235 with C or better or NE 235 with C or better or RHP 235 with C or better

Equivalent to: NE 236, RHP 236

NSE 311, INTRODUCTION TO THERMAL-FLUID SCIENCES, 4 Credits

Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are included. CROSSLISTED as ME 311/NSE 311.

Prerequisite: (ENGR 212 with C or better or ENGR 212H with C or better) and (MTH 256 [C])

Equivalent to: ME 311, ME 311H, NE 311, NE 311H, NSE 311H

NSE 311H, INTRODUCTION TO THERMAL-FLUID SCIENCES, 4 Credits

Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are included. CROSSLISTED as ME 311/NSE 311.

Attributes: HNRS – Honors Course Designator

Prerequisite: (ENGR 212 with C or better or ENGR 212H with C or better) and (MTH 256 [C] or MTH 256H [C])

Equivalent to: ME 311, ME 311H, NE 311H, NSE 311

NSE 312, THERMODYNAMICS, 4 Credits

Analyzes exergy destruction, machine and cycle processes, law of corresponding states, non-reactive gas mixtures, reactive mixtures, thermodynamics of compressible fluid flow. CROSSLISTED as ME 312/NSE 312.

Prerequisite: ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 312, ME 312, ME 312H, NE 312, NE 312H, NSE 312H

NSE 312H, THERMODYNAMICS, 4 Credits

Analyzes exergy destruction, machine and cycle processes, law of corresponding states, non-reactive gas mixtures, reactive mixtures, thermodynamics of compressible fluid flow. CROSSLISTED as ME 312/NSE 312.

Attributes: HNRS – Honors Course Designator

Prerequisite: ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 312, ME 312, ME 312H, NE 312, NE 312H, NSE 312

NSE 319, *SOCIAL ASPECTS OF NUCLEAR TECHNOLOGY, 3 Credits

Description and discussion of nuclear-related issues as they impact society. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Equivalent to: NE 319

NSE 331, INTRODUCTORY FLUID MECHANICS, 4 Credits

Introduces the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics. CROSSLISTED as ME 331/NSE 331.

Prerequisite: ENGR 311 with C or better or ENGR 311H with C or better or ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 331, ENGR 331H, ME 331, ME 331H, NE 331, NE 331H, NSE 331H

NSE 331H, INTRODUCTORY FLUID MECHANICS, 4 Credits

Introduces the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics. CROSSLISTED as ME 331/ NSE 331.

Attributes: HNRS – Honors Course Designator

Prerequisite: ENGR 311 with C or better or ENGR 311H with C or better or ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 331, ENGR 331H, ME 331, ME 331H, NE 331, NE 331H, NSE 331

NSE 332, HEAT TRANSFER, 4 Credits

Analyzes conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. CROSSLISTED as ME 332/NSE 332.

Prerequisite: ME 331 with C or better or ME 331H with C or better or NSE 331 with C or better or NSE 331H with C or better or NE 331 with C or better or NE 331H with C or better

Equivalent to: ME 332, ME 332H, NE 332, NE 332H, NSE 332H

NSE 332H, HEAT TRANSFER, 4 Credits

Analyzes conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. CROSSLISTED as ME 332/NSE 332.

Attributes: HNRS – Honors Course Designator

Prerequisite: ME 331 with C or better or ME 331H with C or better or NSE 331 with C or better or NSE 331H with C or better or NE 331 with C or better or NE 331H with C or better

Equivalent to: ME 332, ME 332H, NE 332, NE 332H, NSE 332

NSE 401, RESEARCH, 1-16 Credits

Graded P/N.

Equivalent to: NE 401

This course is repeatable for 99 credits.

NSE 403, THESIS/DISSERTATION, 1-16 Credits

Equivalent to: NE 403

This course is repeatable for 16 credits.

NSE 405, READING AND CONFERENCE, 1-16 Credits

Equivalent to: NE 405

This course is repeatable for 16 credits.

NSE 406, PROJECTS, 1-16 Credits

Equivalent to: NE 406

This course is repeatable for 16 credits.

NSE 407, SEMINAR, 1 Credit

Graded P/N.

Equivalent to: RHP 407

This course is repeatable for 16 credits.

NSE 410, INTERNSHIP, 1-12 Credits

Supervised technical work experience at approved organizations. Graded P/N.

Equivalent to: RHP 410

This course is repeatable for 12 credits.

NSE 415, NUCLEAR RULES AND REGULATIONS, 2 Credits

An introduction to the key nuclear regulatory agencies; major nuclear legislation; current radiation protection standards and organizations responsible for their implementation. Offered alternate years.

Prerequisite: NSE 236 with C or better

Equivalent to: NE 415, RHP 415

Recommended: NSE 481 or NE 481 or RHP 481

NSE 429, SELECTED TOPICS IN NUCLEAR ENGINEERING, 1-3 Credits

Topics associated with nuclear engineering not covered in other undergraduate courses; topics may vary from year to year.

Equivalent to: NE 429

This course is repeatable for 45 credits.

NSE 435, RADIATION SHIELDING AND EXTERNAL DOSIMETRY, 4 Credits

Theoretical principles of shielding for neutron and gamma radiation; external dosimetry fundamentals for neutrons, photons, and charged particles; applications to problems of practical interest; analytical, numerical, and computer solutions emphasized.

Prerequisite: (NSE 234 with C or better or NE 234 with C or better or RHP 234 with C or better) and (NSE 235 [C] or NE 235 [C] or RHP 235 [C]) and (NSE 481 [C] or NE 481 [C] or RHP 481 [C])

Equivalent to: NE 435

NSE 440, NUCLEAR FUEL CYCLE AND WASTE MANAGEMENT, 4 Credits

Mining, milling, conversion, enrichment, fuel fabrication, reprocessing, and waste management of nuclear fuel, including disposal of low- and high-level radioactive waste.

Prerequisite: NSE 235 with C or better or NE 235 with C or better or RHP 235 with C or better

Equivalent to: NE 440

NSE 450, PRINCIPLES OF NUCLEAR MEDICINE, 3 Credits

Basic principles of nuclear medicine; detectors; radiopharmaceutical; dosimetry; imaging procedures.

NSE 451, NEUTRONIC ANALYSIS I, 3 Credits

Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory, one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions.

Prerequisite: (MTH 256 with C or better or MTH 256H with C or better) and (NSE 235 [C] or NE 235 [C] or RHP 235 [C]) and (NSE 333 [C] or NE 333 [C] or RHP 333 [C])

Equivalent to: NE 451

NSE 452, NEUTRONIC ANALYSIS II, 3 Credits

Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory, one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions. Lec/lab.

Prerequisite: NSE 451 with C or better or NE 451 with C or better

Equivalent to: NE 452

NSE 455, REACTOR OPERATOR TRAINING I, 3 Credits

The Oregon State University TRIGA reactor Operator Training I class is one of a two-course series. Students interested in participating in this course are expected to enroll in both the NSE 455/NSE 555 and NSE 456/NSE 556 classes taught during spring and summer terms. Students successfully completing the NSE 455/NSE 555 and NSE 456/NSE 556 series will culminate their course work with the opportunity to take a certification test proctored by the Nuclear Regulatory Commission.

Prerequisite: (NSE 236 with C or better or NE 236 with C or better or RHP 236 with C or better) and (MTH 256 [C] or MTH 256H [C])

Equivalent to: NE 455

NSE 456, REACTOR OPERATOR TRAINING II, 4 Credits

The Oregon State University TRIGA reactor Operator Training II class is one of a two-course series. Students interested in participating in this course must have already taken and successfully passed NSE 455/NSE 555. Students successfully completing NSE 455/NSE 555 will culminate their course work with the opportunity to take a certification test proctored by the Nuclear Regulatory Commission.

Prerequisite: NSE 455 with C or better or NE 455 with C or better

Equivalent to: NE 456

NSE 457, NUCLEAR REACTOR LABORATORY, 2 Credits

Experimental investigation of the principles of nuclear reactor operation. Use of the OSU TRIGA Reactor and other laboratory facilities. Preparation and presentation of laboratory reports. Lec/lab.

Prerequisite: (NSE 451 with C or better or NE 451 with C or better or NSE 551 with C or better or NE 551 with C or better) and (NSE 452 [C] or NE 452 [C] or NSE 552 [C] or NE 552 [C])

Equivalent to: NE 457

NSE 467, NUCLEAR REACTOR THERMAL HYDRAULICS, 4 Credits

Hydrodynamics and conductive, convective and radiative heat transfer in nuclear reactor systems. Core heat removal design; critical heat flux, hot spot factors, single- and two-phase flow behavior. Advanced thermal hydraulic computer codes.

Prerequisite: ME 332 with C or better or ME 332H with C or better or NSE 332 with C or better or NSE 332H with C or better or NE 332 with C or better or NE 332H with C or better

Equivalent to: NE 467

NSE 473, NUCLEAR REACTOR SYSTEMS ANALYSIS, 3 Credits

Analysis of nuclear light water reactor (pressurized water reactor and boiling water reactor) design and operation, including the nuclear steam supply system, engineered safety features and balance of plant systems; regulatory design requirements; industry standards; plant engineering and instrumentation drawings. Advanced reactor system designs.

Prerequisite: NSE 452 with C or better or NE 452 with C or better

Equivalent to: NE 473

NSE 474, ^NUCLEAR SYSTEMS DESIGN I, 4 Credits

Part I of a two-part series aimed at developing the student's ability to utilize fundamental nuclear and radiation protection skills to transform concepts into practical designs. Design projects involve the integration of neutronics, thermal hydraulics, safety and risk analysis, power production, materials, radiation protection, economic optimization, statistics and other skills. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: NSE 481 with C or better

Equivalent to: NE 474, RHP 474

NSE 475, ^NUCLEAR SYSTEMS DESIGN II, 4 Credits

Part II of a two-part series aimed at developing the student's ability to utilize fundamental nuclear and radiation protection skills to transform concepts into practical designs. Design projects involve the integration of neutronics, thermal hydraulics, safety and risk analysis, power production, materials, radiation protection, economic optimization, statistics and other skills. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: (NSE 452 with C or better or NE 452 with C or better) and (NSE 474 [C] or NE 474 [C] or RHP 474 [C])

Equivalent to: RHP 475

NSE 481, RADIATION PROTECTION, 4 Credits

Fundamental principles and theory of radiation protection; regulatory agencies, dose units; source of radiation; biological effects and risk; dose limits; applications of external and internal dosimetry; shielding and atmospheric dispersion.

Prerequisite: NSE 235 with C or better or NE 235 with C or better or RHP 235 with C or better

Equivalent to: NE 481, RHP 481

NSE 483, RADIATION BIOLOGY, 3 Credits

Biological effects of ionizing radiation at the molecular, cellular, and organismal levels with emphasis on vertebrates; both acute and chronic radiation effects are considered.

Prerequisite: NSE 481 with C or better or RHP 481 with C or better or MP 481 with C or better

Equivalent to: MP 483

NSE 488, RADIOECOLOGY, 3 Credits

Radionuclides in the environment: their measurement and identification, uptake and transfer through food chains. Effect of radiation on natural populations of plants and animals.

Prerequisite: NSE 481 with C or better or RHP 481 with C or better or NE 481 with C or better

Equivalent to: RHP 488

NSE 499, SPECIAL TOPICS, 0-16 Credits

Equivalent to: NE 499

This course is repeatable for 16 credits.

NSE 501, RESEARCH, 1-16 Credits

Equivalent to: MP 501

This course is repeatable for 99 credits.

Available via Ecampus

NSE 503, THESIS, 1-16 Credits

Equivalent to: MP 503

This course is repeatable for 999 credits.

Available via Ecampus

NSE 505, READING AND CONFERENCE, 1-16 Credits

Equivalent to: MP 505

This course is repeatable for 16 credits.

Available via Ecampus

NSE 506, PROJECTS, 1-16 Credits

Equivalent to: MP 506

This course is repeatable for 16 credits.

Available via Ecampus

NSE 507, SEMINAR, 1 Credit

Graded P/N.

Equivalent to: MP 507

This course is repeatable for 16 credits.

Available via Ecampus

NSE 510, INTERNSHIP, 1-12 Credits

Supervised technical work experience at approved organizations. Graded P/N.

Equivalent to: MP 510

This course is repeatable for 16 credits.

NSE 515, NUCLEAR RULES AND REGULATIONS, 2 Credits

An introduction to the key nuclear regulatory agencies; major nuclear legislation; current radiation protection standards and organizations responsible for their implementation. Offered alternate years.

Equivalent to: NE 515, RHP 515

Available via Ecampus

NSE 516, RADIOCHEMISTRY, 4 Credits

Selected methods in radiochemical analysis. Actinide chemistry, activation analysis, radionuclide solvent extraction, and microbial reactions with radionuclides. Designed for majors in chemistry, chemical engineering, nuclear engineering, and radiation health physics. Lec/lab. **CROSSLISTED** as CH 516/NSE 516.

Prerequisite: (NSE 531 with C or better or NE 531 with C or better or RHP 531 with C or better) and (NSE 536 [C] or NE 536 [C] or RHP 536 [C])

Equivalent to: CH 516, RHP 516

NSE 517, RADIONUCLIDES IN LIFE SCIENCES, 4 Credits

Chemistry of actinides and fission products, radioseparations, selected medical generators, radiolabeling of organic molecules. Designed for majors in medical physics, radiation health physics, chemistry, pharmacy.

Prerequisite: (NSE 531 with C or better or NE 531 with C or better or RHP 531 with C or better) and (NSE 536 [C] or NE 536 [C] or RHP 536 [C])

Equivalent to: MP 517, RHP 517

NSE 519, RADIOCHEMICAL ANALYSIS, 4 Credits

Hands-on learning of radiochemistry, practical training with open radiation sources for preparation of irradiation targets, counting samples from contaminated soils or separation of medical radionuclides.

Fundamentals of chemical dosimetry are also covered. Designed for a broad range of majors in chemistry, nuclear engineering, radiation health physics, radioecology, chemical and environmental engineering. Lec/lab. The lecture part of the course also is delivered online as video stream via Canvas.

Prerequisite: NSE 536 with C or better or NE 536 with C or better or RHP 536 with C or better

Equivalent to: NE 519, RHP 519

Recommended: NSE 516

NSE 521, RADIOLOGICAL ANATOMY AND PHYSIOLOGY, 4 Credits

Anatomy and physiology with correlating images for use by medical physicists, therapists, dosimetrists. This course adheres to the AAMD requirements for Cross Sectional Anatomy.

Equivalent to: MP 521, RHP 521

NSE 522, NUCLEAR SECURITY SCIENCE, 4 Credits

Explores the nuclear fuel cycle from the perspective of nuclear security and safeguards and in the context of current international nuclear policies. Nuclear threats are balanced with the past history of nuclear weapons use, current nonproliferation technology, and the future international growth of the nuclear industry. Critical thinking will be assessed by way of in-class discussions, journal article reviews, written analysis of fuel cycle signatures, and conducting research. Signatures including radiological and morphological characteristics of nuclear material is introduced as well as the techniques for the detection of special nuclear materials.

NSE 525, NUCLEAR SECURITY SYSTEM DESIGN, 3 Credits

Studies the science and engineering associated with the design, evaluation, and implementation of systems to secure nuclear and radiological materials. Topics include adversary characterization, target categorization and the consequences of failure to protect targets, detection and delay technologies, on-site and off-site response and response strategies, insider threat evaluation, and mathematical methods for evaluating risk due to the threat and the security system design. Students will become familiar with the components of a sustainable nuclear security program and their interconnections, and learn about the planning of nuclear security activities at both the state and facility level.

NSE 526, NUMERICAL METHODS FOR ENGINEERING ANALYSIS, 3 Credits

Numerical solutions of linear equations, difference equations, ordinary and partial differential equations. CROSSLISTED as ME 526/NSE 526.

Equivalent to: ME 526, NE 526

Recommended: Programming experience and previous exposure to numerical methods

NSE 531, RADIOPHYSICS, 3 Credits

Expands understanding of concepts and applications of atomic and nuclear physics to enable continued study in nuclear engineering and health physics. Includes fundamental concepts of nuclear and atomic physics, atomic and nuclear shell structure, radioactive decay, radiation interactions, radiation biology, and the characteristics of fission.

Equivalent to: MP 531

Available via Ecampus

NSE 533, DETECTION OF SPECIAL NUCLEAR MATERIALS, 3 Credits

Designed for students interested in radiation measurements and nuclear security, especially those considering PhD-level work in this area. Covers topics including special nuclear material characteristics, radiation background and its interferences with SNM, an introduction to MCNPX, a brief introduction to Geant4, detection of SNM via counting or imaging, localization of SNM; and characterization of SNM.

Prerequisite: NSE 536 with C or better

Recommended: MTH 251 or MTH 251H

NSE 534, APPLIED DETECTION FOR NUCLEAR SECURITY, 3 Credits

Applied detection techniques currently being deployed globally for nuclear security are presented in lectures and explored in practical exercises. A prominent feature of this class is the unique opportunity to complete the Nuclear Security Education Program (NSEP) Training program hosted at the HAMMER federal training center.

Prerequisite: NSE 536 with C or better

NSE 535, RADIATION SHIELDING AND EXTERNAL DOSIMETRY, 4 Credits

Theoretical principles of shielding for neutron and gamma radiation; external dosimetry fundamentals for neutrons, photons, and charged particles; applications to problems of practical interest; analytical, numerical, and computer solutions emphasized.

Equivalent to: MP 535, NE 535, RHP 535

Available via Ecampus

NSE 536, ADVANCED RADIATION DETECTION AND MEASUREMENT, 4 Credits

Principles and mechanisms underlying nuclear radiation detection and measurements; operation of nuclear electronic laboratory instrumentation; application of gas-filled, scintillation and semiconductor laboratory detectors for measurement of alpha, beta, gamma, and neutron radiation, liquid scintillation equipment; use of Bonner spheres for neutron energy profiles; experimental investigation of interactions of radiation with matter. Lec/lab.

Prerequisite: NSE 531 with C or better or NE 531 with C or better or RHP 531 with C or better or MP 531 with C or better

Equivalent to: MP 536

NSE 537, DIGITAL RADIATION MEASUREMENT AND SPECTROSCOPY, 3 Credits

Principles of digital spectroscopy; application of digital filters in digital processing of detector pulses; hardware implementation of a typical digital spectrometer; introduction of Field-Programmable Gate Array (FPGA) devices programming a digital spectrometer using Hardware Description Language (VHDL); simulation, synthesis and spectroscopy; experimental design tests and evaluation. Lec/lab.

Prerequisite: NSE 536 with C or better or NE 536 with C or better or RHP 536 with C or better

Equivalent to: NE 537

NSE 539, SELECTED TOPICS IN INTERACTION OF NUCLEAR RADIATION, 1-6 Credits

Topics associated with interactions of nuclear radiation not covered in other graduate courses; topics may vary from year to year.

Equivalent to: NE 539

NSE 540, NUCLEAR FUEL CYCLE AND WASTE MANAGEMENT, 4 Credits

Mining, milling, conversion, enrichment, fuel fabrication, reprocessing, and waste management of nuclear fuel, including disposal of low- and high-level radioactive waste.

Equivalent to: NE 540

NSE 541, DIAGNOSTIC IMAGING PHYSICS I, 3 Credits

An introduction to the production and usage of ionizing radiation in medicine. The course will cover x-ray production, x-ray spectrum, characteristics and manipulation, and how x-rays are utilized to obtain anatomical information in diagnostics imaging. Imaging modalities to be covered in this course are general and portable planar radiography, mammography, and fluoroscopy (including interventional radiography).

Prerequisite: NSE 531 with C or better or MP 531 with C or better or RHP 531 with C or better

Equivalent to: MP 541

NSE 542, DIAGNOSTIC IMAGING PHYSICS II, 3 Credits

An introduction to Computed Tomography (CT) and Ultrasound (US) imaging, and their applications in medicine. The course will cover x-ray production, detection, and image processing as it relates specifically to CT, as well as general acoustic physics principles and how they are applied to US imaging. Additionally, clinical radiation protection and dosimetry in diagnostic imaging will be taught.

Prerequisite: NSE 531 with C or better or PP 531 with C or better or RHP 531 with C or better

Equivalent to: MP 542

NSE 543, ADVANCED DIAGNOSTIC IMAGING PHYSICS, 3 Credits

An introduction to the areas of health informatics and magnetic resonance imaging (MRI). The health informatics portion of the course will specifically cover picture archiving and communication systems (PACS), including DICOM standards, data transfer and storage, digital image displays, and clinical implementation of PACS systems. The MRI portion of the course will provide instruction on the physical principles behind nuclear magnetic resonance (NMR) and how these phenomenon are exploited in MRI. Advanced MRI techniques and applications, along with clinical testing requirements, will also be covered.

Prerequisite: NSE 531 with C or better or MP 531 with C or better or RHP 531 with C or better

Equivalent to: MP 543

NSE 544, NUCLEAR MEDICINE IMAGING, 3 Credits

An introduction to the uses of radionuclides in medical imaging. The theory and application of detectors and imaging systems in nuclear medicine including collimators, scintillation probes, cameras, SPECT, PET, and hybrid technologies (SPECT/CT, PET/CT, and PET/MRI) will be covered.

Prerequisite: (NSE 541 with C or better or MP 541 with C or better) and (NSE 531 [C] or RHP 531 [C])

Equivalent to: MP 544

NSE 545, DIAGNOSTIC IMAGING PRACTICUM, 3 Credits

Provides an introduction to the medical physicist's role in a clinical department; an opportunity to integrate principles learned throughout the graduate program as they apply to diagnostic imaging physics. Observations of procedures in radiography, fluoroscopy, ED, OR, interventional radiology, CT, MRI, ultrasound, and nuclear medicine. Experience in regulatory testing of x-ray equipment; observations of testing of CT and other x-ray modalities. Graded P/N.

Prerequisite: (NSE 541 with C or better or MP 541 with C or better) and (NSE 531 [C] or MP 531 [C] or RHP 531 [C])

Equivalent to: MP 545

NSE 549, SELECTED TOPICS IN NUCLEAR FUEL CYCLE ANALYSIS, 1-6 Credits

Topics associated with the nuclear fuel cycle not covered in other graduate courses; topics may vary from year to year.

Equivalent to: NE 549

This course is repeatable for 45 credits.

NSE 550, PRINCIPLES OF NUCLEAR MEDICINE, 3 Credits

Basic principles of nuclear medicine; detectors; radiopharmaceutical; dosimetry; imaging procedures.

Equivalent to: RHP 550

NSE 551, NEUTRONIC ANALYSIS I, 3 Credits

Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory; one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions.

Equivalent to: NE 551

NSE 552, NEUTRONIC ANALYSIS II, 3 Credits

Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory; one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions.

Prerequisite: NSE 551 with C or better or NE 551 with C or better

Equivalent to: NE 552

NSE 553, ADVANCED NUCLEAR REACTOR PHYSICS, 3 Credits

Advanced analytic and numerical techniques for the prediction of the neutron population in nuclear reactor systems. Topic will include long characteristic neutron transport, collision probabilities, nodal methods, equivalence theory, and perturbation theory.

Prerequisite: (NSE 551 with C or better or NE 551 with C or better) and (NSE 552 [C] or NE 552 [C])

Equivalent to: NE 553

Recommended: Computer programming experience

NSE 555, REACTOR OPERATOR TRAINING I, 3 Credits

The Oregon State University TRIGA Reactor Operator I class is one of a two-course series. Student interested in participating in this course are expected to enroll in both the NSE 455/555 and NSE 456/556 classes taught during spring and summer terms. Students successfully completing the NSE 455/555 and NSE 456/556 series will culminate their course work with the opportunity to take a certification test proctored by the Nuclear Regulatory Commission.

Equivalent to: NE 555

NSE 556, REACTOR OPERATOR TRAINING II, 4 Credits

The Oregon State University TRIGA Reactor Operator Training II class is one of a two-course series. Students interested in participating in this course must have already taken and successfully passed NSE 455/ NSE 555. Students successfully completing NSE 456/NSE 556 will culminate their course work with the opportunity to take a certification test proctored by the Nuclear Regulatory Commission.

Prerequisite: NSE 555 with C or better or NE 555 with C or better

Equivalent to: NE 556

NSE 557, NUCLEAR REACTOR LABORATORY, 2 Credits

Experimental investigation of the principles of nuclear reactor operation. Use of the OSU TRIGA Reactor and other laboratory facilities. Preparation and presentation of laboratory reports. Lec/lab.

Prerequisite: (NSE 551 with C or better or NE 550 with C or better) and (NSE 552 [C] or NE 552 [C])

Equivalent to: NE 557

NSE 559, SELECTED TOPICS IN NUCLEAR REACTOR ANALYSIS, 1-3 Credits

Topics associated with nuclear reactor theory not covered in other graduate courses; topics may vary from year to year.

Equivalent to: NE 559

This course is repeatable for 45 credits.

NSE 561, NUCLEAR REACTOR SYSTEMS LABORATORY, 3 Credits

Operational aspects of nuclear reactor systems; neutronic and thermal-hydraulic characterization of nuclear reactors; examination of design basis accident prevention and mitigation; loss of coolant accidents; loss of flow accidents; station blackouts. Lec/lab.

Prerequisite: (NSE 553 with C or better or NE 553 with C or better) and (NSE 567 [C] or NE 567 [C])

Equivalent to: NE 561

NSE 562, RADIATION THERAPY, 3 Credits

The physics of radiation generation and delivery relevant to the field of clinical radiation oncology. Topics will include external beam radiation therapy; dosimetric calculations; high dose-rate and low dose-rate brachytherapy; electron beam dosimetry and treatment planning; special techniques in radiotherapy; and clinical radiation protection and quality assurance.

Prerequisite: NSE 531 with C or better or MP 531 with C or better or NE 531 with C or better or RHP 531 with C or better

Equivalent to: MP 562

NSE 563, APPLIED RADIATION THERAPY PHYSICS LABORATORY I, 3 Credits

The applied practice of therapeutic radiation physics for clinical radiation oncology. Topics will include current methodologies in treatment delivery and planning algorithms, best practices and protocols for quality assurance, special techniques in radiotherapy, and oncology.

Prerequisite: NSE 562 with C or better or MP 562 with C or better

Equivalent to: MP 563

NSE 564, APPLIED RADIATION THERAPY PHYSICS LABORATORY II, 3 Credits

Covers the applied practice of therapeutic radiation physics for clinical radiation oncology. Topics include current methodologies in SRS and ARC QA, treatment planning QA, adaptive radiotherapy, eye plaque brachytherapy and HDR brachytherapy.

Equivalent to: MP 564

NSE 565, APPLIED THERMAL HYDRAULICS, 3 Credits

Advanced topics in the computational modeling of the hydrodynamic and heat transfer phenomena of nuclear reactors. Steady-state and transient solutions of one-dimensional nuclear reactor thermal hydraulic models. Nuclear reactor behavior analysis during various accident scenarios.

Equivalent to: NE 565

NSE 567, NUCLEAR REACTOR THERMAL HYDRAULICS, 4 Credits

Hydrodynamics and conductive, convective and radiative heat transfer in nuclear reactor systems. Core heat removal design; critical heat flux, hot spot factors, single- and two-phase flow behavior. Advanced thermal hydraulic computer codes.

Equivalent to: NE 567

NSE 568, NUCLEAR REACTOR SAFETY, 3 Credits

Focused on probability risk assessment and system reliability analysis techniques applied to nuclear reactor safety. Application of these methods will be performed specifically through examination of neutronics and thermal hydraulic transients, effectiveness of emergency systems, accident prevention and mitigation, and assessment of radioactive release to the environment.

Prerequisite: (NSE 551 with C or better or NE 551 with C or better) and (NSE 567 [C] or NE 567 [C])

Equivalent to: NE 568

NSE 569, SELECTED TOPICS IN NUCLEAR REACTOR ENGINEERING, 1-6 Credits

Advanced nuclear engineering design concepts, reactor systems analysis techniques and innovative nuclear engineering applications. Artificial intelligence and expert system applications to nuclear engineering problems. Topics may vary from year to year.

Equivalent to: NE 569

This course is repeatable for 30 credits.

NSE 573, NUCLEAR REACTOR SYSTEMS ANALYSIS, 3 Credits

Analysis of nuclear light water reactor (pressurized water reactor and boiling water reactor) design and operation, including the nuclear steam supply system, engineered safety features and balance of plant systems; regulatory design requirements; industry standards; plant engineering and instrumentation drawings. Advanced reactor system designs.

Prerequisite: NSE 552 with C or better or NE 552 with C or better

Equivalent to: NE 573

NSE 574, NUCLEAR SYSTEMS DESIGN I, 4 Credits

Part I of a two-part series aimed at developing the student's ability to utilize fundamental nuclear and radiation protection skills to transform concepts into practical designs. Design projects involve the integration of neutronics, thermal hydraulics, safety and risk analysis, power production, materials, radiation protection, economic optimization, statistics and other skills.

Equivalent to: RHP 574

NSE 575, NUCLEAR SYSTEMS DESIGN II, 4 Credits

Part II of a two-part series aimed at developing the student's ability to utilize fundamental nuclear and radiation protection skills to transform concepts into practical designs. Design projects involve the integration of neutronics, thermal hydraulics, safety and risk analysis, power production, materials, radiation protection, economic optimization, statistics and other skills.

Prerequisite: (NSE 551 with C or better or NE 551 with C or better) and (NSE 552 [C] or NE 552 [C]) and (NSE 574 [C] or NE 574 [C])

Equivalent to: RHP 575

NSE 582, APPLIED RADIATION SAFETY, 4 Credits

Application of radiation protection as practiced in the fields of nuclear science and engineering; application of health physics principles to reduce health hazards at each of the following stages: design, prevention, assessment, and post-incident. A history of key nuclear regulatory agencies; early and current radiation protection standards and organizations responsible for their formulation; major nuclear legislation; pertinent nuclear rules and regulations and their application. Lec/lab.

Equivalent to: MP 582

NSE 583, RADIATION BIOLOGY, 3 Credits

Biological effects of ionizing radiation at the molecular, cellular, and organismal levels with emphasis on vertebrates; both acute and chronic radiation effects are considered.

Equivalent to: MP 583

NSE 584, RADIATION BIOLOGY II, 3 Credits

Application of radiobiological models in radiation therapy. Some background in radiation biology is strongly recommended.

Equivalent to: MP 584, RHP 584

NSE 588, RADIOECOLOGY, 3 Credits

Radionuclides in the environment: their measurement and identification, uptake and transfer through food chains. Effect of radiation on natural populations of plants and animals.

Equivalent to: RHP 588

Recommended: NSE 481 or RHP 481 or NE 481

Available via Ecampus

NSE 590, INTERNAL DOSIMETRY, 3 Credits

Further development and more in-depth treatment of internal dosimetry concepts, theoretical basis of energy deposition, biokinetics, and estimation of radiation risk from ingested, inhaled, or injected radionuclides.

Prerequisite: NSE 531 with C or better and NSE 535 [C]

Equivalent to: NE 590, RHP 590

NSE 599, SPECIAL TOPICS, 0-16 Credits

Equivalent to: MP 599

This course is repeatable for 16 credits.

NSE 601, RESEARCH, 1-16 Credits

Graded P/N.

Equivalent to: MP 601

This course is repeatable for 99 credits.

NSE 603, THESIS, 1-16 Credits

Equivalent to: MP 603

This course is repeatable for 999 credits.

NSE 605, READING AND CONFERENCE, 1-16 Credits

Equivalent to: MP 601

This course is repeatable for 16 credits.

NSE 606, PROJECTS, 1-16 Credits

Equivalent to: MP 606

This course is repeatable for 16 credits.

NSE 607, SEMINAR, 1-16 Credits

Graded P/N.

Equivalent to: MP 607

This course is repeatable for 16 credits.

NSE 610, INTERNSHIP, 1-16 Credits

Equivalent to: MP 610

This course is repeatable for 16 credits.

NSE 654, COMPUTATIONAL PARTICLE TRANSPORT, 3 Credits

Properties of and methods for solution of the linear Boltzmann equation for nuclear reactors; spherical and double-spherical harmonics; integral equation methods; Monte Carlo methods.

Prerequisite: (NSE 551 with C or better or NE 551 with C or better) and (NSE 552 [C] or NE 552 [C])

Equivalent to: NE 654

NSE 667, ADVANCED THERMAL HYDRAULICS, 3 Credits

Advanced topics in single- and two-phase hydrodynamics and heat transfer for nuclear reactors. Two-phase flow patterns, flow instabilities, condensation induced transients, convective boiling heat transfer, and current topics in reactor safety thermal hydraulics. Offered alternate years.

Prerequisite: NSE 567 with C or better or NE 567 with C or better

Equivalent to: NE 667

NSE 699, SPECIAL TOPICS, 0-16 Credits

Equivalent to: NE 699

This course is repeatable for 16 credits.

NSE 808, WORKSHOP, 1-4 Credits

Equivalent to: NE 808

This course is repeatable for 16 credits.