Nuclear Engineering

Chair and Professor: Pope

Professors: Brey, Imel

Research Professor: Schultz

Associate Professor: Dunzik-Gougar

Assistant Professors: Ali, LaBrier

Emeriti: Gesell, Kunze

Doctor of Philosophy in Nuclear Science and Engineering

This program combines the atomic nuclear aspects of engineering and science. Research areas range from the more traditional nuclear engineering disciplines (reactor physics, thermal hydraulics, and reactor design) to cross-discipline topics in the fields of health physics, radiation detection and measurement, nuclear fuels, materials development, nuclear fuel cycle systems studies, and radioactive waste management.

Goals

- Prepare graduates to conduct and disseminate independent scholarly research.
- Prepare graduates for careers in academia or industry.

Objectives

- Increase the knowledge of graduates in their specialized field: chemistry, engineering (all disciplines), geosciences, mathematics, and physics.
- Enhance the ability of graduates to contribute to their chosen field.
- Enhance effective written and oral communication skills of graduates.

Master of Science in Nuclear Science and Engineering

The master’s degree program in Nuclear Science and Engineering prepares the student for advanced placement in the nuclear industry in commercial, research, or development areas. It provides in-depth studies and advanced design concepts in several areas of modern nuclear science and engineering. It is also an excellent program of study for entering the doctoral program in Nuclear Science and Engineering.

Goals

- Enhance the knowledge of graduates in the physics and engineering of nuclear reactors, the nuclear fuel cycle, and other aspects of the study of nuclear engineering. At Idaho State University, while our emphasis is on advanced reactors and the science and technology of nuclear fuel recycling, we allow the flexibility to build programs on other aspects, which can include systems studies and simulations including policy aspects, radiation shielding and detection, medical applications of radiation, and the economics and safety of all of these applications.
- Increase the ability of graduates to synthesize and apply these advanced concepts to develop realistic nuclear engineering designs and to solve identified problems, designing strategies for implementing them safely, ethically, and effectively.
- Enhance the ability of graduates to effectively communicate these concepts both in oral and written formats.

Master of Science in Health Physics

The Nuclear Engineering Program additionally offers the master's option in Health Physics. Health Physics, an applied science, is concerned with the protection of humans and their environment from the possible harmful effects of radiation while providing for its beneficial uses. It is a multi-disciplined profession that incorporates aspects of both the physical and biological sciences. The master's program in Health Physics is accredited by the Applied Sciences Accreditation Commission of ABET, *http://www.abet.org.* The Idaho State University Health Physics programmatic educational objectives have been developed in close collaboration of faculty and the Idaho State University Health Physics Program Advisory Board.

The educational objectives of the ISU Health Physics program are to produce health physicists with:

1. broad, fundamental technical knowledge;
2. written and verbal communication skills;
3. professional judgment and capability to think critically;
4. practical experience in solving applied health physics problems;
5. the ability to work independently; and
6. a professional ethic of magnitude sufficient for them to work productively and successfully in a variety of health physics settings.

The graduate program has two additional educational objectives, to equip graduates with:

1. An ability to conduct research; and
2. Professional tools and experience above that expected for the baccalaureate program.

Students may enter the master's program in health physics from several undergraduate majors including health physics, physics, chemistry, biology, and other science or engineering majors. Additional course work to correct deficiencies may be necessary.

Certificate Program in Applied Nuclear Energy

This program provides bachelor's degree graduates who do not have recent experience or education in the nuclear energy field with historical insights, information on basic concepts, regulatory requirements, and economic and environmental considerations. The Certificate is granted upon completion of fourteen (14) credit hours of classwork, consisting of nine credit hours of required courses, a three-credit elective course, and participation in two semesters of a one-credit graduate seminar. Up to six credits of appropriate graduate course work taken at another university may be applied toward the certificate program subject to approval by the student’s certificate committee. With appropriate pre-planning, some of these credits could be applied to a master’s degree.

Doctor of Philosophy in Nuclear Science and Engineering

Admission Requirements

All applicants must meet Idaho State University Graduate School admission requirements for doctoral programs. Additionally, applicants must have attained a master’s degree in engineering, physics, chemistry, geosciences, mathematics, or a closely related field. Applicants must submit a one-page (only) statement

of research interests, a one-page (only) statement of career interests, a resume, and at least 2 letters of reference along with their applications. In some special cases, a student with exceptional undergraduate academic record and aptitude for research, but without an M.S. degree, may be directly admitted to the Ph.D. program with the approval of the Ph.D. program committee.

General Requirements

The doctoral degree requires completion of at least 84 credits consisting of 32 credits for the master's degree, 18 credits of additional course work (at least 50% of the credits must be at 6600 level), 4 credits of graduate seminar and 32 credits of dissertation research. Six credits of core courses are required for each emphasis area. At least 9 of the 18 credits of course work must be in collateral areas as designated by the student's advisor. Additional dissertation research credits may be required by the student's dissertation committee.

Program of Study

An advisor, a Graduate Faculty member from the student's parent department, will be identified for each student upon entering the program. The advisor will guide the student in establishing their program of course work and laboratory study based upon the student's background and research interest. The advisor has the responsibility of ensuring that the student has adequate knowledge to support research in his or her chosen area of interest.

At the end of the first year, the student will take an 8-hour written, comprehensive qualifying examination covering the relevant information addressed in a nuclear engineering B.S. curriculum (including nuclear physics, reactor physics, reactor engineering, and nuclear fuel cycle). A student taking the comprehensive qualifying exam needs to be prepared to take an oral examination conducted by the examination committee. The oral exam needs to focus primarily on material in the written exam that was not adequately answered. However, the examination committee, at its discretion, may excuse a student from taking the oral examination if the student excels in the written examination. The student will be allowed two attempts to pass the comprehensive examination, and the second attempt must be within one-half year after the first attempt. The student will be admitted to candidacy upon passing the comprehensive qualifying examination.

A dissertation committee is formed with a minimum of 5 members consisting of a major professor, 2 members from the student's parent department, a member from another relevant department, and a Graduate Faculty Representative. The major advisor chairs the dissertation committee. Typically, within six months of passing the comprehensive qualifying examination, the candidate, with guidance from the major advisor, will satisfactorily complete an oral presentation and defense of a written proposal for dissertation research to the dissertation committee. The research and dissertation preparation must be conducted under the close supervision of the committee and must include at least one full year of work performed under Idaho State University graduate faculty. The candidate can submit the final dissertation any time after acceptance of the research proposal.

Dissertation approval requires a public presentation of the dissertation and a satisfactory oral defense to the dissertation committee. Doctoral oral examinations are open to all regular members of the faculty as observers. Further, oral presentations are open to the public until questioning by the dissertation committee begins.

Master of Science in Nuclear Science and Engineering

Admission Requirements

The student must apply to and meet all criteria for admission to the Graduate School and hold a BS degree in a physical science or engineering.

General Requirements

The basic program requirements are 32 credits: 24 credits of course work (of which 9 credits must be at the 6600-course level), 6 credits of thesis research, and 2 credits of seminar. Students who are prepared with a B.S. degree in nuclear engineering will have a different course schedule than those with B.S. degrees in other engineering fields or a physical science. Therefore, the student’s program will be determined in consultation with the student’s advisor and committee to meet their needs. An oral examination in defense of the thesis is required for the thesis option.

Thesis Option in Engineering Master’s Programs

All students entering with less than two years of industrial experience as determined by Engineering are required to complete six credits of thesis in their related field. Students who are planning to continue their education beyond the master's level are strongly encouraged to choose this option. After the completion of the course work and the thesis, an oral defense of the thesis will be required. No more than six credits of Thesis (ENGR 6650 Thesis, 1-9 credits) will be allowed on the student’s final Program of Study.

Non-Thesis Option in Engineering Master’s Programs

All students entering with a minimum of two years industrial experience in the related area as determined by Engineering are eligible to choose this option. In the non-thesis program, students will be required to take an additional 3-credit course to complete a 3-credit Special Project (ENGR 6660 Special Project, 1-9 credits) in the related field and submit a written report. After completion of the coursework and the Special Project, students are required to take a two-hour oral exam on their Special Project and other courses in the MS program. No more than three credits of Special Project will be allowed on the student’s final Program of Study.

Master of Science in Health Physics

Admission Requirements

For admission, the student must apply to and meet all criteria for admission to the Graduate School, including a baccalaureate degree in a physical or biological science or engineering.

General Requirements

The basic program requirements are 33 credits, of which 15 credits must be at the 6600-course level. Six of the eighteen required credits may be thesis. Students who are prepared with some education and experience in Health Physics will likely not need all of the elective Health Physics courses. Therefore, the student’s program will be determined in consultation with the student’s advisor and committee and can include electives to meet his/her needs. An oral examination in defense of the thesis is required for the thesis option. A non-thesis option is also available.

Nuclear Engineering and Health Physics

Certificate Program in Applied Nuclear Energy

Admission Requirements

The student must apply to and meet all criteria for admission to the Graduate School. GRE scores are not required if an earned grade point average of at least 3.0 or higher was achieved for all upper-division credits taken at the undergraduate level, regardless of the institution at which the credits were earned.

Code	Title	Credits
Required Courses		
NSEN 6615	Introduction to Practical Nuclear Engineering	3

NSEN 6617	Applications of Nuclear Energy	3
NSEN 6651	Nuclear Engineering Seminar	1
Electives		
Select one of the following:		3
ENGR 6606	Environmental Law and Regulations	3
HPHY 6610	Radiation Regulations	3
NSEN 6618	Radioactive Waste Management	3
NSEN 6619	Materials Science of Radwaste	3
Approved NE, NSEN, ENGR, ENVE or PHYS 55xx/66xx elective course.		

Courses

NE 5519 Energy Systems and Nuclear Power: 3 semester hours.
Fundamentals of conventional and renewable energy systems. Energy sources, distribution, use and environmental effects. Nuclear power plant "balance of plant" design. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: ME 3307 and MATH 3360 or instructor permission.

NE 5521 Mathematical Methods in Nuclear Engineering: 3 semester hours.
First and second order ordinary differential equations (ODEs), generalization to systems of ODEs, Laplace transforms, series solutions to second order ODEs, special functions and Sturm-Liouville systems; partial differential equations by separation of variables. Examples will emphasize practical problems of interest to nuclear engineers. PHYS 6602 may be substituted for this course. PREREQ: MATH 3360.

NE 5543 Thermal Fluids Laboratory: 1 semester hour.
Measurement of thermal and fluid properties, experiments on fluid flow and heat transfer systems. Equivalent to ME 5543. PREREQ: ME 3341 and NE 5576 or NE 4476.

NE 5545 Reactor Physics: 3 semester hours.
Neutron balance equations in reacting systems, diffusion and diffusion-perturbation theory, introductory reactor kinetics, the multi-group energy approach, neutron slowing down and thermalization, introductory concepts in reactor systems. PREREQ: NE 3302 or NSEN 6685, and NE 5521 or equivalent.

NE 5546 Nuclear Fuel Cycle Systems: 3 semester hours.
Uranium mining, milling, conversion; enrichment technology including cascade analysis; fuel fabrication, criticality safety in the nuclear fuel cycle, introdution to ORIGEN and Monte-Carlo methods and codes, reactor fuel management, waste management (LLW, HLW, TRU waste). PREREQ: NE 3302 or NSEN 6684 or equivalent.

NE 5548 Design Control and Use of Radiation Systems: 3 semester hours.
Generation detection and measurement systems design for control and use of neutrons and gamma rays in industrial and medical applications. Radiation protection, regulations, environmental and economic considerations. COREQ: ENGR 5545.

NE 5551 Nuclear Seminar: 1 semester hour.
Current topics in nuclear science and engineering. Specific, evaluted graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Graduate student status in NSEN or HPHY program.

NE 5558 Monte Carlo Methods and Applications: 3 semester hours.
Basics of the application of stochastic methods to calculate the transport of neutrons, photons, and other sub0-atomic particles. Includes introduction to the MCNP code, and sample application problems in both nuclear reactor design and in applications such as radiation beams used for cancer therapy.

NE 5576 Heat Transfer: 3 semester hours.
Principles and engineering applications of heat transfer. Analysis of conduction, convection and radiation heat transfer. Design of heat exchangers. Cross-listed as ME 5576. PREREQ: ME 3341.

NE 5578 Reliability and Risk Assessment: 3 semester hours.
Methods of evaluating process and equipment reliability. Probabilistic methods applied to analysis and design. Setting probabilistic design objectives and calculating probabilistic performance. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: MATH 3360 and EE 4416 or permission of instructor.

NE 5587 Medical Applications in Engineering and Physics: 3 semester hours.
Applications of engineering and physics, principles, particularly nuclear science, to medicine. Covers radioisotopes, x-ray imaging, magnetic resonance and ultrasound imaging, radiation protection, codes and standards. PREREQ: MATH 3360 and PHYS 2212.

NE 5588 Nonproliferation and Safeguard: 3 semester hours.
Science and technology-oriented case studies, technical basis, and management of material accountancy and inventory control; technologies and practices for safeguarding special nuclear materials; detection of nuclear proliferation. PREREQ: permission of instructor

NE 5599 Experimental Course: 1-6 semester hours.
The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

NE 6699 Experimental Course: 1-6 semester hours.
The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

NE 8850 Doctoral Dissertation: 1-24 semester hours.
Research toward completion of the dissertation for the Ph.D. in Engineering and Applied Science. Variable credits. May be repeated. Graded S/U.