MEASUREMENTS

Introduction

The guidelines outlined in this document are intended to supplement the general information on graduate programs provided by Nuclear Engineering and Radiological Sciences (NERS), the College of Engineering, and the Rackham Graduate School.

Master's and Doctoral Degree Requirements

See the Rackham School of Graduate Studies Academic Policies website for graduation requirements information at: http://www.rackham.umich.edu/policies/academic_policies/. Also, see the supplementary Master's and Ph.D. Graduation Requirements and corresponding checklists for Nuclear Engineering and Radiological Sciences. All checklists should be reviewed in the term prior to graduation for the master's degree and the term in which candidacy is achieved for the doctoral program.

Graduate Advising

Students will be assigned an advisor when they first join the graduate program. However, this assignment can be changed if student's interest or needs change, and students should not be reluctant to talk to the NERS graduate committee chair or their advisors once they have come to understand how their interests mesh with those of the various faculty members in the department. For students carrying out graduate research, the research supervisor is also their academic advisor. Before registering for a future term, the student should discuss courses with the advisor.

Measurements Research

This graduate option encompasses coursework and research dealing with radiation measurements and spectroscopy, nuclear instrumentation, imaging of radiation, radiation safety, environmental sciences, and medical physics. Similar to other option guidelines in the NERS graduate program, this guide provides a framework of formal courses and examination for students interested in pursuing advanced practice in numerous application areas. Various topics of research include:

- Neutron and gamma ray detector design
- Measurements of fundamental atomic and nuclear parameters
- Methods and algorithm development for detector systems
- New technologies for nuclear treaty verification
- Neutron activation analysis
- Radiation imaging systems
- Nondestructive assay of nuclear materials, including active interrogation using external radiation sources and passive detection techniques for homeland security and nonproliferation applications
- Radiation safety and health physics to protect people and the environment from radiation
- Environmental sciences as related to nuclear radiation, such as the environmental impact of nuclear fuel cycles including the mining and fabrication of uranium and thorium ores, reactor operation and nuclear waste disposal.
- Decommissioning of nuclear facilities, risk evaluation, measurement and management of radionuclides

- Applied radiation shielding
- Radiation dose estimation, including external sources and internally deposited radionuclides
- Radiation transportation risk assessment
- Medical physics such as radiation therapy physics

The emphasis of the radiation measurements option covers the scientific and technical areas that are important in the measurement of ionizing radiation. Application areas include nuclear non-proliferation, homeland security, national security, astrophysics, fundamental science, nuclear power, planetary sciences, the applied use of radiation for industry and medicine, diagnostic imaging in medicine, nuclear physics, the measurement of fundamental nuclear properties, the design of instruments for the detection and spectroscopy of ionizing radiation, systems for imaging radiation fields, and methods for the identification and quantification of radioisotopes. Graduates with interest in radiological health engineering (health physics) or medical physics should also consider the specialization described later.

Other Master's Degree Option Requirements

In addition to the department's general requirements, the Measurements option recommends the specific courses described below. Listed first is a set of "common" courses that serve as a basis for the option and partially satisfy the master's degree requirements of the Department. These course sequences are only guides and each student should plan a program in consultation with an academic advisor that best suits individual needs. For students who wish to pursue studies aligned with health physics, environmental impacts of radiation, or medical physics, a specialized set of courses listed under the radiological health section are provided below.

Graduate Courses for the Measurements Program

Fall Terms

NERS 515	Nuclear Measurements Lab
NERS 518	Advanced Radiation Measurements and Imaging
NERS 441/543 or NERS 551	Nuclear Reactor Theory I / II or Nuclear Reactor Kinetics
NERS 535	Detection Techniques for Nuclear Nonproliferation
NERS 590	Nuclear Safeguards (odd-numbered years)

Elective Recommendations

EECS 501 or equiv	Probability and Random Processes
EECS 423	Solid-State Device Laboratory
EECS 451	Digital Signal Processing & Analysis
EECS 458	BioMed Instrumentation & Design
EECS 564	Estimation, Filtering, and Detection

Graduate Courses in Radiological Health Option

NERS 484	Radiological Health Engineering Fundamentals
NERS 584	Radiation Biology
NERS 531 or NERS 585	Nuclear Waste Management or Transportation of Radioactive Materials
EHS 550	Introduction to Occupational and Environmental Health

Winter Terms

NERS 554 or NERS 544	Radiation Shielding or Monte Carlo Methods
NERS 425	Application of Radiation (lab)
NERS 481	Engin. Princ. of Rad. Imaging
NERS 580	Comp Proj. Rad. Imaging

Elective Recommendations

EECS 516	Medical Imaging Systems

Radiological Health Options

NERS 579	Physics of Diagnostic Radiology
NERS 586	Applied Radiation Measurements Lab
NERS 555	Radiological Physics and Dosimetry
NERS 581	Radiation Therapy Physics
NERS 583	Radiological Dose Assessment and Response

Ph.D. Candidacy Exam

In the Nuclear Measurements option the written examination covers topics in:

- Basic quantum and nuclear physics
- Interaction of radiation with matter
- Basic electrical circuits
- Radiation detection and measurement
- Probability, counting statistics, and uncertainty analysis
- Digital methods and general computer architectures

Although the material on the written examination is primarily drawn from topics covered in courses such as NERS 425, 481, 515, 518, and 535, a fundamental understanding of radiation physics, mathematics, quantum mechanics, and electrical engineering has been found to be essential in successfully tackling this exam. Students intending to perform research in the radiological health engineering or medical physics areas may request a written exam focused in this topic.

Because of the diversity of background and interests of the entering students as well as the rapid change of technology, it is impossible to prescribe a course sequence applicable to all entering doctoral- track students. Therefore, consulting the student's advisor is recommended in order to ensure the most relevant courses are selected for the student's educational goals. However, students planning on continuing into the doctoral program should complete their fundamental coursework during their first two semesters, and attempt the written exam at the first opportunity thereafter.

Primary Faculty in the Measurements Option and their Specialties

Ronald Fleming, Professor Emeritus Neutron Activation
David Wehe, Professor, Radiation Imaging
Zhong He, Professor, Room Temperature Semiconductor Imaging Detectors
Kimberlee J. Kearfott, Professor, Radiological Sciences
Alex F. Bielajew, Professor, Computational Medical Physics
Sara Pozzi, Professor, Detection for Nuclear Nonproliferation
Igor Jovanovic, Professor, Applied Nuclear Science
Mark D. Hammig, Associate Research Scientist, Novel radiation detection methods
Yuefeng Zhu, Assistant Research Scientist, Semiconductor Detector Development
Shaun Clarke, Associate Research Scientist, Nonproliferation simulation methods
Kristy Brock, Adjunct Professor
Martha Matuszak, Assistant Professor of Radiation Oncology, Medical School
Michael Flynn, Adjunct Professor, Medical Microtomography (Henry Ford Hospital)
Ruth Weiner, Adjunct Professor, Radiological Risk Evaluation (Sandia National Laboratories)
Mitch Goodsitt, Adjunct Professor, Diagnostic Radiology (UM School of Medicine)
Imre Pazsit, Adjunct Professor, Chalmers University of Technology, Sweden
Neal Clinthorne, Research Professor, UM Department of Radiology