

GRADUATE PROGRAM HANDBOOK

Department of Nuclear Engineering

The Pennsylvania State University

Academic Year 2021-2022



PennState
College of Engineering

**KEN AND MARY ALICE
LINDQUIST DEPARTMENT OF
NUCLEAR ENGINEERING**

This publication is available in alternative media on request. The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. It is the policy of the University to maintain an academic and work environment free of discrimination, including harassment. The Pennsylvania State University prohibits discrimination and harassment against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, gender identity, or veteran status. Discrimination or harassment against faculty, staff, or students will not be tolerated at The Pennsylvania State University. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Director, The Pennsylvania State University, 328 Boucke Building, University Park, PA 16802-2801; Tel 814-865-4700/V, 814-863-1115

2020-2021 GRADUATE STUDENT HANDBOOK

TABLE OF CONTENTS

INTRODUCTION

Introduction	1
--------------------	---

GENERAL ADMINISTRATIVE POLICIES

Graduate Program Office	2
ID Cards, PSU Email	2
Mail, Parking, Offices, Keys,	2
Assistantship Responsibilities	3
Health Insurance	3
Reporting Resources	3

ACADEMIC PROCEDURES FOR GRADUATE STUDENTS

Graduate Degree Programs Bulletin	4
Grading System	4
Unsatisfactory Scholarship	4
Dropping/Adding Courses	4
Auditing Courses	5
Full-Time Academic Status	5
Course Loads	5
Transfer Credits	6
Transfer of Nondegree Credits	6
Courses	6
NUCE 590, (colloquium)	6
NUCE 596, 600 (610)	7
Limits on Research Credits	7
NUCE 601 (611)	7
Maintaining Satisfactory Scholarship	8

MASTER OF ENGINEERING PROGRAM

Admissions Requirements	9
Provisional Admission	9
Examinations for Admission	9
Nuclear Security Option - MENG	9
Program Requirements	9
Selection of a Faculty Reader	10
Summary of MENG Degree Requirements	10

MASTER OF SCIENCE DEGREE PROGRAM

Admissions Requirements	11
Provisional Admission	11
Examinations for Admission	11
Nuclear Security Option - MS	11
Program Requirements	11
Summary of MS Degree with Thesis Requirements	12

DOCTOR OF PHILOSOPHY DEGREE PROGRAM

Admissions Requirements 13
Examinations for Admission 13
Program Requirements 13
Qualifying Examination 13
Qualifying Examination – Written Portion 13
Qualifying Examination – Oral Portion 14
Residency Requirement 14
Language and Communications Requirement 14
The Doctoral Committee 15
Comprehensive Exam 15
Continuous Registration 15
Final Oral Examination 16
Summary of PHD Degree Requirements 17

SARI (Scholarship and Research Integrity)

Scholarship and Research Integrity (CITI & SARI RCR) 18

FACILITIES

The Radiation Science and Engineering Center 19
TRIGA Reactor 19
Neutron Beam Laboratory 19
Nuclear Security Education Lab 19
Radiochemistry Teaching and Research Laboratory 20
Radionuclear Applications Laboratory 20
Co60 Gamma Ray Irradiation 20
Hot Cells 20
Subcritical Graphite Reactor 20

COURSE DESCRIPTIONS

Undergraduate 400 Level Courses 22
Graduate 500 Level Courses 24

FACULTY RESEARCH INTERESTS

Faculty Research Interests 25

REPORTING RESOURCES

Reporting and Additional Student Resources 26

Introduction

Welcome to the Ken and Mary Alice Lindquist Department of Nuclear Engineering at Penn State. We hope your experience with us will contribute to your personal and professional development. Nuclear Engineering is a challenging but rewarding major, in which you will likely have to combine knowledge from many different disciplines to achieve your goals. The faculty members are well prepared to assist you, and you will have the advantage of the experimental and computational facilities in the program, especially the Radiation Science and Engineering Center and the Breazeale Nuclear Reactor. Also, be aware that as a high-quality research university, Penn State has a multitude of research and educational resources outside the department that can benefit you. We encourage you to seek out these opportunities to take full advantage of your time at Penn State.

The degrees of Master of Science, Master of Engineering, and Doctor of Philosophy in nuclear engineering are offered in the department. New students are encouraged to visit the Graduate Program Assistant, Beth Huber, in 205 Hallowell Building, for the assignment of an academic advisor. With the help of your advisor, each student's program of study will be tailored with regard to their particular interest. Generally, your research advisor takes over as the academic advisor when your research activity is determined. To ensure that you can meet with your advisor and discuss your academic program, please make an appointment prior to the desired meeting time.

Students enroll in classes using LionPATH, <http://launch.lionpath.psu.edu/node/2>. Any questions concerning registration procedures, dates and schedules can be directed to the Graduate Staff Assistant. You need to consult your advisor before registering for classes. **Please note that our main way to contact you is via e-mail.** You are assigned an e-mail address when you join Penn State; you are responsible for checking it often.

All graduate students in the Nuclear Engineering Program are required to register for NUCE 590 Colloquium. Masters students need to register for this course throughout their graduate work, and Ph.D. students need to register continuously until they pass their comprehensive exam. These seminars are given by prominent researchers, officials, and industry representatives, and represent an important part of a student's education in the field of nuclear engineering, beyond what is taught in the classroom and what is learned in research.

The student chapter of the American Nuclear Society (ANS) is a focal point of professional and social activity for students and faculty in Nuclear Engineering. The ANS organizes seminars, conducts field trips under Nuclear Engineering Program auspices, conducts public information programs, and provides services to the Program and undergraduate and graduate students. I encourage you to consider joining the chapter and to actively support it. For more information, visit: <https://sites.psu.edu/americanuclearsociety/> or contact Prof. William Walters wjw24@psu.edu. You may also consider joining the Institute for Nuclear Materials management (INMM) <https://sites.psu.edu/inmm/about-us/> or contact Prof. Azaree Linteur, al21@psu.edu. I also draw your attention to the Graduate Student Association (GSA), <http://gpsa.psu.edu/> and recommend your consideration and participation in its activities.

If you have any questions or problems, please see your academic advisor, or the Nuclear Engineering Graduate Program Office. In addition, I am always willing to meet and discuss any issues or concerns you may have.

Again, welcome to Penn State!



Prof. Arthur T. Motta
Chair of Graduate Studies atm2@psu.edu

General Administrative Policies

GRADUATE PROGRAM OFFICE

The Graduate Program Office for Nuclear Engineering is located in 206 Hallowell Building. The Program Assistant, Allison Singer, is available to assist students during scheduled appointment times. She can be reached via email, ars6534@psu.edu, to schedule.

ID CARDS

- Every Penn State campus has an office that issues id+ cards (20 HUB-Robeson Center). There is no charge for your first card.
- When you come to the id+ Office, you will need to present a valid form of ID: driver's license, passport, state-issued photo ID, military ID, government-issued photo ID, high school photo ID with a Social Security Card, college ID with a Social Security Card, or a Permanent Resident Card.
- Students transferring to University Park from another Penn State campus do not need a new id+ card.

PSU EMAIL

The Graduate Program Office uses e-mail to notify students of various announcements, events, etc. All graduate students are required to use their Penn State e-mail account for all correspondence regarding your academics. If you choose to use an account other than the one provided you are responsible for all information contained in your PSU account. Please refer to the Information Technology Services (ITS) website for more information: <http://identity.psu.edu/services/authentication-services/access-accounts/>.

Additionally, the Graduate Programs Office sends e-mail to graduate students on a regular basis during the Fall and Spring Semesters about job opportunities, fellowships, university activities, workshops, etc.

MAIL HANDLING

1. Incoming graduate student mail and items ordered for research will be placed in an alphabetized unit in 311 Hallowell Building. Please check it often, as mail will not be held indefinitely.
2. The default mailing address for graduate students is: 206 Hallowell Building, Atherton St., University Park, PA 16802. This address should be used only for professional purposes.

PARKING

Every employee or student need a parking permit to park on campus. Individuals enrolled in classes at Penn State are classified as students and must obtain student parking through the Parking Office. Please refer to policies and online registration procedures at: <http://www.transportation.psu.edu/>.

Parking registration must be completed [online](#). All permits are sold on a first come, first served basis. PermitDirect™ will provide a printable temporary permit allowing students to park immediately.

OFFICES - Students will be provided an office to perform their teaching or research assistantship duties.

KEYS - Keys are individually numbered and assigned to each person. If you terminate your graduate studies or graduate, keys must be returned to the NUCE Facilities Office in 205 Hallowell Building. Access to Hallowell Building is gained by the use of the PSU student ID card. Please contact Danielle Snyder by email dlh65@psu.edu to discuss obtaining access to the building.

Assistantship Responsibilities

A graduate student on a 1/2-time assistantship is expected to work a minimum of 20 hours per week. These work requirements can include thesis research activities.

All international students who have been offered assistantships which involve classroom interaction with undergraduate students are required to have passed the American English Oral Communicative Proficiency Test (AEOCPT), as a result of a State law and Penn State Faculty Senate Legislation. This test is administered before the semester begins by the Department of Applied Linguistics (<http://aplng.la.psu.edu/programs/about-the-aeocpt>). Teaching Assistantships within Nuclear Engineering do not involve classroom interaction, therefore the AEOCPT exam is not a requirement.

UNIVERSITY HEALTH SERVICES

The University Health Service is located in the Student Health Center which is adjacent to the Eisenhower Parking Deck and the Bank of America Career Services Building off Bigler Road. Its facilities are available to all students, including graduate students at all levels of training.

HEALTH INSURANCE

Health insurance is mandatory for all Graduate Students and Students with RA or TA appointments are automatically enrolled. As a graduate student, you are eligible to purchase health care at a subsidized rate for the Graduate Assistant and Graduate Fellow medical, dental and vision plans. This is valid for you and for any eligible dependents. Students enrolled in the university health insurance plan have their premiums automatically deducted from their paycheck. The deadline to purchase, decline, or change dependents for Fall 2019 is 9/8/2019.

You are urged to review the policies at <https://studentaffairs.psu.edu/health> and contact University Health Services directly at 814-865-6556 if you have and questions regarding Penn State Student Health insurance.

Counseling and Psychological Resources for Graduate Students

Counseling and Psychological Services (CAPS) can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Common concerns include difficulty with friends, roommates, or family members; depression and anxiety; sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs. All consultations are strictly confidential.

You can contact their office by calling 814-863-0395 or visit their website for more information. <http://studentaffairs.psu.edu/counseling/>

REPORTING RESOURCES

All members of the Penn State community are asked to remain mindful of their individual commitment to Penn State's core values of [Respect, Integrity, Responsibility and Community](#) by helping to keep the University a safe and ethical institution. In addition, as members of this community, everyone should be responsible stewards of University funds, whether generated from state, federal, student, or other sources. The University does not condone wrongful conduct by any member of the Penn State community, no matter what position he or she may hold. Penn State University encourages the reporting of misconduct. **If you see something, say something.** You can report misconduct, in the assurance that the University will protect you from retaliation. See [AD67](#) or contact the [Office of Ethics & Compliance](#) for more information.

Additional reporting resources available for faculty, staff, students, and others are shown on page 23.

Academic Procedures for Graduate Students

GRADUATE DEGREE PROGRAMS BULLETIN

The Graduate Degree Programs Bulletin (<http://bulletins.psu.edu/bulletins/whitebook/index.cfm>) contains policies mandated by the Graduate School regarding academic procedures, registration requirements, conduct, resolution of problems and procedures for termination, MS degree and Ph.D. degree requirements, as well as other procedures, regulations and requirements as related to graduate study.

GRADING SYSTEM

Grades shall be assigned to individual students on the basis of the instructor's judgment of the student's scholastic achievement using the grading system below.

Undergraduate and Graduate Grading System

Quality of Performance		Grade	Grade Point Equivalent
Excellent	Exceptional Achievement	A	4.00
		A-	3.67
Good	Extensive Achievement	B+	3.33
		B	3.00
		B-	2.67
		C+	2.33
Satisfactory	Acceptable Achievement (Does not count for Graduate Study)	C	2.00
		D	1.00
Failure	Inadequate Achievement (To secure credit, course must be repeated.)	F	0.00

For graduate students, a minimum grade-point average of 3.00 for work done at the University is required for graduation.

UNSATISFACTORY SCHOLARSHIP

A graduate student who fails to maintain satisfactory scholarship or to make acceptable progress in a degree program may be dropped from the University. One or more failing grades or a cumulative grade-point average below 3.00 for any semester or session or combination of semesters and/or sessions may be considered as evidence of failure to maintain satisfactory scholarship. Action may be initiated by the department or committee in charge of the graduate major or by the chair of the student's committee.

ENROLLING IN CLASSES

Course Registration – All students must register for classes prior to the Late Registration period which can be found at http://www.registrar.psu.edu/academic_calendar/calendar_index.cfm. If you do not register before that date, you will be assessed a late-add fee and a late registration fee. If you are on a half-time graduate assistantship, you must register for 9-12 credits per semester. International students must be registered full-time, or for 9 credits in order to maintain their visa status.

DROPPING and ADDING COURSES

In case you need to drop a course, please consider whether this will have an impact on your visa status (you need to be enrolled for 9 credits in order to be considered a full-time student)

Penn State University maintains three periods relating to course drops: the pre-semester period, the add-drop period, and the late drop period.

1. The **pre-semester period** begins on the first day of scheduling and ends the day before the semester starts.
2. The **regular drop/add period** is the 5 day period which starts the day courses start. During that timeframe, a course can be dropped or added without a drop/add fee. Please refer to the [Registrar's Academic Calendar](#) for specific dates.
 - No signature(s) required.
 - No fee
3. The **late drop period** starts the day after the regular drop period and before the late drop deadline (see the academic calendar),
 - No signature(s) required
 - A fee for each transaction
 - Courses are recorded on the student record as LD

AUDITING COURSES

Courses taken formally as audit are not included in the maximum number of credits required for assistantships or for satisfying visa requirements for international students. **The request to audit a course must be done within the regular drop add period.** The adding of an audited course after the regular drop/add period is not permitted. Requests to audit a course must be made to the instructor who offers the course. Once instructor approval is granted, student must complete the [Registration Drop/Add form](#) and submit the completed form to the Registrar's Office. *Please note that the tuition requirement is the same for an audited course.*

FULL-TIME ACADEMIC STATUS

Full-time academic status is achieved by taking appropriate course loads. Most loan granting agencies and other organizations consider a 9-credit course load to be full-time status, fulfilling their registration requirements. The U.S. Immigration and Customs Enforcement (ICE) requires that all international students on student visas must achieve "full-time Academic status" during the Fall and Spring semesters. Exceptions to this rule are possible under certain conditions. Students should contact the University Office of Global Programs for further information. For ICE purposes, a course load of nine credits is considered full-time during Fall and Spring semesters, and during the Summer semester, international students do not have to register. Any graduate student registered for NUCE 601 (Note: Student must have passed the Ph.D. comprehensive exam in the prior semester) is considered to have full-time academic status. For full details, see the Graduate Degree Programs Bulletin website at <http://bulletins.psu.edu/bulletins/whitebook/index.cfm>.

COURSE LOAD

Full-time students and students receiving fellowships should register for 9-12 credits per semester. All students (US and international) receiving assistantships should register for the following:

Appointment	Fall/Spring	Summer
1/4-time assistantship	9-14 credits/semester	5-7 credits
1/2-time assistantship	9-12 credits	4-6 credits
3/4-time assistantship	6-8 credits	3-5 credits

MS students are not required to register for course work or research once the course requirements have been met. The Graduate School requires that all students receive a cumulative grade point average of 3.0 or better to graduate. After passing the comprehensive exam, all Ph.D. students must maintain "continuous registration," which requires them to register for NUCE 601 (Ph.D. Thesis Preparation) for the Fall and Spring semesters. If Ph.D. students plan to take their oral or comprehensive exams during the Summer Session, they must be registered. Also, Ph.D. students must spend at least two semesters over some 12-month period during the interval between completion of

the Qualifying exam and completion of the Ph.D. program as a registered full-time student. For full details, see the Graduate Degree Programs Bulletin website at <http://bulletins.psu.edu/bulletins/whitebook/index.cfm>.

TRANSFER OF CREDITS

Transfer of Credit from an External Institution

A student may request for a maximum of ten (10) credits of high-quality graduate work done at a regionally accredited institution or recognized degree-granting institution to be applied toward the requirements for a master's degree. Approval to apply any transferred credits toward a degree program must be granted by the Department Head or Graduate Program Chair, and the Graduate School. However, credits earned to complete a previous master's degree, whether at Penn State or elsewhere, may not be applied to a second master's or doctoral degree at Penn State.

Transfer credits must meet the following criteria:

- Must have been earned at a recognized degree-granting institution in the United States;
- Must be of "A" or "B" grade value ("B-" grades are not acceptable; pass-fail grades are not transferable unless substantiated by the former institution as having at least "B" quality);
- Must appear on an official graduate transcript;
- Must be earned within the five years prior to the date of registration to a degree program at Penn State.

Forms for transfer of credit may be found at <http://gradschool.psu.edu/current-students/>

Transfer of Non-degree Graduate Credits

Approval to apply non-degree graduate credits toward a degree program must be granted by the Department Head or Graduate Program Chair, and the Graduate School. A maximum of 15 credits earned at PSU as a non-degree student may be applied to a degree program.

- The credits must have been earned within five years preceding entry into the degree program.
- Only upper level undergraduate and graduate courses may be transferred.
- Only A, B, and C grades may be transferred.

Forms for transfer of credit may be obtained from the graduate program.

Courses

Graduate courses carry numbers from 500 to 599 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level will not count. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

A total of 24 course credits are required for the M.S. degree, 12 of which must be at the 500-level and 12 of which must be in Nuclear Engineering. A total of 27 course credits are required for the MEng degree with the same requirements regarding 500-level and Nuclear Engineering courses. Both NUCE Masters programs (M.S. and MEng) require that a student take NUCE 450 (Radiation Detection and Measurement). Students with a B.Sc. in Nuclear Engineering may be excused from this requirement.

NUC E 590 (graduate seminar)

This course includes seminars by outside speakers (from academia, industry or government), faculty and senior graduate students. These seminars represent an important part of the student's education.

- All Nuclear Engineering graduate students registered at a full-time level are required to schedule this course, during the Fall and Spring Semesters, with the exception of PhD students who successfully complete the comprehensive exam are then excused from the NUCE 590 registration requirement.
- Credits earned from this course do not count towards the 30 credits required for graduation with an MS or MEng degree.
- Students who are registered at a level less than full time, (9 credits) or during the summer semester are not required to enroll in NUCE 590.

Requests for exceptions to the registration requirements listed above can be made to the Chair of Graduate Studies in the Nuclear Engineering Program and are evaluated on a case-by-case basis.

NUCE 596, 600 (610), 601 (611)

Graduate students registering for these courses must first consult with their advisor (or the instructor if different from advisor) to ensure that they are registering for the appropriate course. Failure to select the correct course may require the student to pay "retroactive drop/add fees" and perhaps additional course-credit fees. The NucE Graduate Programs staff can also assist graduate students in registering for the appropriate course.

NUCE 596 - INDIVIDUAL STUDIES "Research for Writing Meng paper" - Creative projects, including non-thesis research, that are supervised on an individual basis and which fall outside the scope of formal courses. NUCE 596 cannot be used for M.S. or Ph.D. thesis research. A minimum of 3 credits of NUCE 596, supervised by the student's advisor is required when submitting a research paper. Achievement of a quality letter grade is required.

NUCE 600 (610 if research is Off-Campus) - THESIS RESEARCH - This course should be used to register for M.S. and Ph.D. thesis research. A minimum of 6 credits of NUCE 600, supervised by the student's advisor is required when submitting a thesis. There is no limit on the total number of credits of 600 a student can take. However, there is a maximum number of credits which a student can receive a quality letter grade (A, B, etc.). A student must receive a non-letter grade (R, etc.) for any additional credits of 596/600. The R grade is assigned for satisfactory completion of research (<http://bulletins.psu.edu/graduate/academicprocedures/procedures6>).

LIMITS ON RESEARCH CREDITS (NUCE 600)

Students registering for 600 or 610 should be aware that Graduate Council has established limits on the total number of research credits that can be assigned letter grades in a student's program (i.e., other than R). Students are not permitted to have more graded credits of research than stated by the policy:

<http://bulletins.psu.edu/graduate/academicprocedures/procedures5>

NUCE 601 (611 Part time) - Ph.D. THESIS PREPARATION

Only Ph.D. students who have passed the comprehensive examination are permitted to enroll in 601. Ph.D. students are eligible for 601 in the semester following their comprehensive exam and have met the two semester residency requirement. Ph.D. students can register for one additional course either for credit or audit (up to 3 credits) when they are registered for NUCE 601/611. Students who are eligible must contact the NUCE Graduate staff to enroll in NUCE 601. *Note that NUCE 601 cannot be used to meet the residency requirement.*

It is important that graduate students consult with their advisor prior to each semester's registration to ensure that they are registering for the appropriate courses.

Maintaining Satisfactory Scholarship

A minimum grade point average of 3.00 is required in order to be granted a graduate degree in Nuclear Engineering.

If in a review of the student's grade point average, the minimum requirements are not met, a letter (signed by the advisor) to the student from the Graduate Faculty of the Nuclear Engineering will state:

- a. The requirement(s) which the student has failed to satisfy.
- b. The requirement(s) which the student must meet by the end of the next semester.
- c. If the next semester requirement(s) set forth in item b. is not met, the faculty will review the student's academic performance at a meeting convened prior to the end of the first two weeks of the subsequent semester. In the absence of extenuating circumstances, the student will be dropped as a regular graduate student immediately following the meeting.

The student may petition the Graduate Faculty of Nuclear Engineering for admission as a regular graduate student when their cumulative graduate course grade point average is elevated to 3.00 or greater.

Master of Engineering Degree Program

The Master of Engineering (MEng) degree is a professional master's degree. A minimum of 30 credits at the 400, 500, or 800 level is required. Twelve of those credits must be in Nuclear Engineering with at least 18 credits at the 500 level. Students need to take the NUCE 450 Radiation Detection and Measurement course (3 credits). This requirement may be waived for students with a B.Sc. in Nuclear Engineering; however, the minimum of 30 credits is still required. Students must petition the head of the graduate program to review their undergraduate transcripts to assess their eligibility for a waiver. The program culminates with a scholarly paper completed while the student is enrolled in NUCE 596 (3 cr.). The scholarly paper must be approved by the adviser, a faculty reader, and the associated head of graduate studies chair.

Admission Requirements

Completion of an undergraduate degree in Nuclear Engineering or in another related engineering or science discipline is required for admission to the MEng degree program in Nuclear Engineering. Students should have at least a 3.00 (4.00 base) junior-senior average to be considered for admission.

Provisional Admission

Provisional admission (non-degree status) is a temporary classification in which an applicant may remain for a period of no longer than 2 semesters following admission or the time it takes to accrue 15 credits. If the deficiencies that caused the provisional admission are not corrected by this time, the student may be dropped from the program. A maximum of 15 credits of courses taken as non-degree can be transferred to a degree program. Therefore, it is imperative that non-degree students apply to degree status prior to exceeding this limit.

Nuclear Security Option - MEng

An option in Nuclear Security is available for students taking the MEng degree. To follow that option, students must complete 15 credits in the following courses: NUCE 441 (3 credits), NUCE 442 (3 credits), NUCE 542 (3 credits), NUCE 543 (3 credits), and NUCE 544 (3 credits).

Program Requirements – MEng in NUCE

Each of the following requirements must be met in order for a student to be approved for graduation:

1. A minimum of 30 graduate credits must be earned. Only grades of A, B, and C are accepted for graduate credit.
2. A minimum grade point average (GPA) of 3.00 is required, not counting grades obtained in NUCE 596 Individual Studies.
3. At least twelve (12) 400- or 500-level course credits must be taken as NUCE courses. A minimum of six credits must be NUCE 500-level courses.
4. At least eighteen (18) of the 30 required credits must be in 500-level courses. This includes NUCE 596 as well as any 500-level NUCE courses taken to satisfy requirement #3 above. A letter grade must be assigned in NUCE 596. NUCE 600 cannot be used as a substitute to meet this requirement.
5. Candidate writes a paper on a topic mutually agreed upon by the advisor suitable for publication in a professional journal or presentation at a national or international conference. Students must take three (3) credits of NUCE 596 - Individual Studies in Nuclear Engineering representing formal recognition of the student's effort spent on writing a paper on an engineering subject. A quality letter grade in NUCE 596 is required.
 - The final paper must be approved by the student's advisor, a faculty reader who is a current member of the Nuclear Engineering Graduate Faculty, and Chair of Graduate Studies.
6. The remaining credits must be courses at the 400- and/or 500-level as selected by the student with approval by the student's advisor as having significance and value for the degree program.

Specific course requirements:

NUCE 301 (Fall only) *Fundamentals of Reactor Physics* and NUCE 302 (Spring only) *Introduction to Reactor Design*. Students can take NUCE 497 *Fundamentals of Nuclear Engineering*, a three-credit reactor theory course, which is considered an acceptable substitute for NUCE 301 and 302. Students without a BSc in NUCE need to take this course.

NUCE 450 *Radiation Detection and Measurement*. NUCE 497 *Radiation Detection Lab* offered biannually in a short course format is considered an acceptable substitute for NUCE 450.

Selection of a Faculty Reviewer (Paper Reader)

Master's paper reviewers are chosen by the student in conjunction with their advisor. The reader must be a member of the Nuclear Engineering Graduate Faculty and should be appointed in a timely manner to ensure they have adequate time to review the work. If a reader is unable to be determined one can be assigned by the Program Chair upon request.

Summary of Master of Engineering Degree Requirements

It is the student's responsibility to ensure that all requirements have been met.

Requirement	Person Responsible	Suggested Completion Date
Assign a faculty member to serve as faculty advisor	Student	Early in first semester or prior to choosing a paper topic
Establish a program of study	Student, with advisor approval	
Activate your Intent to Graduate on Lionpath	Student	Prior to the Graduate School's deadline date*
Submit draft copy of engineering paper to faculty advisor	Student	Early in last semester
Select a NUCE Faculty Reader and submit a draft of the Master's Paper for their review.	Student in conjunction with the Faculty Advisor	Prior to or early in the semester of graduation
Submit final copy of engineering paper to Program Chair	Student	Prior to the Graduate School's deadline date*
Return keys and any books, software, supplies, etc. to the Nuclear Engineering Office	Student	Prior to departure
Provide one copy of scholarly paper to advisor	Student	Prior to graduation

*Every semester the Graduate School produces a calendar of deadline dates regarding graduation and thesis approval. This calendar is posted at: <http://www.gradschool.psu.edu/calendars/important-dates/>

Master of Science Degree Program

The Master of Science (M.S.) degree program is designed for students to gain advanced knowledge for research, analysis, and design in nuclear engineering. A minimum of 30 credits at the 400, 500, 600, or 800 level is required, with least 18 credits at the 500 and 600 level combined. Twelve credits must be in Nuclear Engineering. Students need to take the NUCE 450 Radiation Detection and Measurement course (3 credits). This requirement may be waived for students with a B.S. in Nuclear Engineering; however, the minimum of 30 credits is still required. Students must petition the head of the graduate program to review their undergraduate transcripts to assess their eligibility for a waiver. Students are required to write a thesis, and at least 6 credits in thesis research (600 or 610) must be taken in conjunction with completing the thesis. The thesis must be approved by the advisers and readers, the head of the graduate program, and the Graduate School.

Admission Requirements

Completion of an undergraduate degree in Nuclear Engineering or in another related engineering or science discipline is required for admission to the MS degree program in Nuclear Engineering. Students should have at least a 3.00 (4.00 base) junior-senior average to be considered for admission.

Provisional Admission

Provisional admission is a temporary classification in which an applicant may remain for a period of no longer than 2 semesters following admission or the time it takes to accrue 15 credits, whichever comes first. If the deficiencies that caused the provisional admission are not corrected by this time, the student may be dropped from the program.

Nuclear Security Option – MS

An option in Nuclear Security is available for the MS degrees. To follow this option, students must complete 15 credits in the following courses: NUCE 441 (3 credits), NUCE 442 (3 credits), NUCE 542 (3 credits), NUCE 543 (3 credits), and NUCE 544 (3 credits).

Program Requirements (MS)

Each of the following requirements must be met in order for the student to be approved for graduation:

1. All Nuclear Engineering students registered at a full-time level are required to schedule colloquium (NUCE 590), during the Fall and Spring Semesters.
2. A minimum of 30 graduate credits must be earned. Only grades of A, B, and C are accepted for graduate credit.
3. A minimum grade point average of 3.00 is required, not counting grades obtained in NUCE 600, Thesis Research.
4. At least twelve (12) 400- or 500-level course credits must be NUCE courses. A minimum of six credits must be NUCE 500-level courses.
5. At least eighteen (18) of the 30 required credits must be in 500-level courses. This includes 6 credits of NUCE 600 Thesis Research, as well as any 500-level NUCE courses taken to satisfy requirement #3 above. **NUCE 596 cannot be used as a substitute to meet this requirement.**
6. The remaining credits must be courses at the 400- and 500-level as selected by the student with approval by the student's advisor as having significance and value for the degree program.

For students with a BS in Nuclear Engineering (some of) these requirements may have already been satisfied. Please consult with your advisor for verification.

NUCE 301 (Fall only) *Fundamentals of Reactor Physics* and NUCE 302 (Spring only) *Introduction to Reactor Design*. Students can take NUCE 497 *Fundamentals of Nuclear Engineering*, a three-credit reactor theory course, which is considered an acceptable substitute for NUCE 301 and 302. This course is aimed at non-nuclear engineering BS students.

NUCE 450 *Radiation Detection and Measurement*. NUCE 497 *Radiation Detection Lab* offered biannually in a short course format is considered an acceptable substitute for NUCE 450.

Six (6) credits of thesis research, NUCE 600, must be taken followed by the submittal of a thesis that meets the Graduate School requirements. The thesis needs to be approved by the student's advisor, the Faculty Reader (who is a current member of the NUCE Graduate Faculty) and the Chair of Graduate Studies.

Summary of Master of Science Degree Requirements

It is the student's responsibility to ensure that all requirements have been met in a timely manner. Please read carefully the section of this manual titled *Academic Policies*.

Requirement	Person Responsible	Suggested Completion Date
Assign a faculty member to serve as faculty advisor	Student	Early in first semester
Establish a program of study	Student, with advisor approval	Within first month of enrollment in NucE grad program
Apply for Graduation in Lionpath	Student	Prior to the Graduate School's deadline date*
Submit draft copy of thesis to faculty advisor	Student	Early in last semester
Submit a complete draft of the thesis to the Thesis Office for format review.	Student	Prior to the Graduate School's deadline date*
Submit final, corrected, signed copy of thesis to the Thesis Office	Student	Prior to the Graduate School's deadline date*
Return keys and any books, software, supplies, etc. to the Nuclear Engineering office	Student	Prior to departure
Provide one hardcover bound copy of thesis to advisor	Student	Prior to graduation

* The Graduate School maintains a calendar of deadline dates regarding graduation and thesis approval. This calendar is posted <http://gradschool.psu.edu/current-students/etd/thesisdissertationperformance-calendar/>

Doctor of Philosophy Degree Program

The Ph.D. program emphasizes scholarly research and helps students prepare for research and related careers in industry, government, and academia. Students are considered formally admitted as PhD candidates after passing written and oral portions of the Qualifying examination. The Ph.D. program is quite flexible, with minimal formal requirements. The Ph.D. degree is awarded upon completion of a program of advanced study that includes a minimum period of residence, the passing of comprehensive, writing a PhD thesis and defend a thesis during the final oral examinations as determined by the student's doctoral committee. Continuous registration is required of all Ph.D. students until the thesis is approved.

Program Requirements

A doctoral program in Nuclear Engineering, as in all other disciplines at The Pennsylvania State University, consists of a collection of a body of work, including state-of-the-art research that meets the minimum requirements of the Graduate School, is assessed by exams and is approved by the Doctoral Committee for each individual candidate. No specified number of courses completed, or credits earned are required by the Nuclear Engineering Program. Typically, 45-55 credits of 400-500 level courses (including your M.S. program) plus NUCE 600 credits are needed. The numbers above (45-55 credits) are not construed as requirements; they are given merely to indicate to the Ph.D. candidate the typical number of graduate course credits taken by students before attaining their Ph.D. A student's individual program is to be worked out in consultation with the student's major advisor and doctoral committee. About half of the course credits should be in Nuclear Engineering courses and the other half in other disciplines, such as math, physics, or another engineering field. Registration in NUCE 590 Colloquium is required until completion of the Comprehensive exam.

A student entering the Ph.D. program without an M.S. or BSc in NUCE must meet the course requirements for an M.S. in NUCE. Courses are: NUCE 301, NucE 302, NUCE 450, and six credits from NUCE 500-level courses, excluding NUCE 596 courses.

Nuclear Engineering Qualifying Exam

Objective: The objective of the Qualifying Exam is to perform an in-depth assessment of the student's preparation and ability to perform doctoral level scientific research. To that end, the basic knowledge of the student is tested with the 4-hour written exam and further explored during the Oral exam.

Format and Frequency: The Qualifying Exam (QE) will be held two times per year – one in the January/February time frame and the other in September/October time frame. The Chair of NucE PhD QE Committee will chair both sessions. Both sessions are the same in format and logistics and all graduate students can take the exam. The QE consists of two parts: a written exam and an oral exam. The judgement of whether a student passes is the responsibility of the committee who will take into account the student's performance in both the written and the oral parts. Each student has two chances to pass the QE.

Written Exam

The written portion of the exam will be divided into 7 areas (additional areas might be added in the future following changes/additions to Nuclear Engineering undergraduate curriculum – 300- and 400-level courses):

1. Nuclear science (Nuclear physics and radiation detection)
2. Reactor physics and analysis
3. Thermal-hydraulics
4. Nuclear materials and fuel performance
5. Nuclear security
6. Plasma science and fusion
7. Radiochemistry

Students take four areas in the written exam out of these 7 areas. The choice of the four areas is specified by the student upon signing up to take the exam and cannot be changed afterwards. The student should consult with the advisor prior to signing up. Do note that the advisor's area needs to be included. The faculty responsible for the area will prepare questions at a level of difficulty commensurate with a distinguished, top-ranked doctoral program in nuclear engineering. The written exam will be closed book (faculty will provide any required additional information to solve the questions).

Assessment of the student's performance in the written exam will take into account both the overall grade in the four questions and the individual grade in each section. Students are expected to demonstrate mastery of the material in all areas. If the student's performance is judged satisfactory, the student will be allowed to take the Oral Exam. If not, they are considered to fail the exam. According to the discretion of the committee, students may be judged to fail the whole written test or for some particular area(s). If a student fails the written portion of the exam in part or in whole, the committee will determine which areas the student has to re-take on the second attempt at the written portion of the exam.

Oral Exam: An oral exam will be held for each student depending on their performance in the written part. The exam will be given by a committee consisting of at least three faculty members. Students will be assigned a paper by their advisor, 10 days before the oral exam. Students write a critical review of the assigned paper and make a technical presentation of its main points and any concerns or deficiencies. Each student must submit a three to five-page technical paper prior to the oral exam on the subject identified for the oral presentation. The language complexity should be similar to that of a thesis. The student must certify that the paper is their original work without review or assistance by others. Students present the paper to the committee and after the presentation the student will be asked questions designed to explore the familiarity of the student with the fundamentals of the nuclear engineering discipline based on the areas of the written exam. The oral exams are scheduled in advance starting in the third week after the written exam. Although the advisor may be present and may ask questions during the oral exam, the advisor does not have a vote in the decision.

Overall Evaluation: The overall evaluation of the student's performance in the Qualifying Exam will take into account both the oral and the written parts. The committee may decide that the student has to re-take only the oral exam or both the written and oral exams. The decision made by the committee is final. If the student fails the Qualifying Exam twice, the student will not be admitted to the Ph.D. program in nuclear engineering.

English Competency: The Graduate School requires a high level of competence in the use of the English language. You will be given an English Proficiency Exam, both oral and written, during your Qualifying exam. Based upon the assessment, coursework in Speech Communication and English will be identified to improve English competency and enable the student to meet the requirement. Competency will be formally attested after examination during the oral part of the Qualifying exam. The paper write-up and oral presentation during the Qualifying Exam also serve for the committee to judge the student's competency in written and oral communication in English. The committee's evaluation will be communicated to the student and the Graduate School at the end of the exam.

The Qualifying Exam Committee and the student's advisor certifies whether adequate proficiency in the English language has been demonstrated based on the paper and the oral exam. A student may pass the Qualifying exam but not be certified in English proficiency. In this case, the complete exam need not be taken again; but simply to demonstrate English proficiency the student may be advised to take a Speech Communication or English course. Upon improvement of English skills, the student must write another paper, make a verbal presentation and respond to questions by the Qualifying Exam Committee and advisor in the same manner.

Residency Requirement

There is no required minimum number of credits or semesters of study to meet residency requirements. However, during some 12-month period between completion of the Qualifying Exam and completion of the Ph.D. degree, the candidate must spend at least two semesters back-to-back (Fall/Spring or Spring/Fall) (including the semester in which the Qualifying examination was taken) as a registered, full-time student engaged in academic work at University Park. Note: NUCE 601 cannot be used to meet the Graduate Schools Residency requirement.

The Doctoral Committee

After the student passes the Qualifying Exam their doctoral committee should be formed. The doctoral committee has the responsibility of administering the Comprehensive Examination and/or approving the written doctoral thesis, and the oral thesis defense. The formation of the doctoral committee is governed by the requirements of the Graduate School, which follow:

- Appointed soon after the student has completed the Qualifying Exam,
- Must include at least four active members of the Graduate Faculty,
- Normally includes at least three graduate faculty members from the Nuclear Engineering Program,
- At least one regular member of the committee must be a Penn State Graduate Faculty member from outside Nuclear Engineering,
- The chair, or at least one co-chair, of the committee must be a faculty member from Nuclear Engineering. If the student is working with a faculty member outside of the Nuclear Engineering Program, that individual can be co-chair of the committee, and
- The student's faculty advisor must notify the Graduate Staff Assistant to appoint a committee. There is a required form that must be completed.

The committee is not limited to four faculty members, and may include additional members who can contribute technical advice regarding the research. External members, e.g., scientists at national laboratories or industry, who are not at the University can be included as special members of a committee.

The doctoral committee is formed by the candidate in consultation with the candidate and main research advisor.

Comprehensive Examination

Students are required to take the PhD comprehensive examination. The objective of the examination is to provide a feedback on the student's thesis project. This examination is administered by the doctoral committee and usually consists of a literature review and thesis proposal. Additional questions can cover the major and related areas of study.

Requirements are as follows:

- Students may not have deferred or missing grades;
- Must be registered full- or part-time for the semester in which the comprehensive Exam is taken, including summers. Being registered for one credit of NucE 600 is sufficient;
- The examination should be taken at least 3 months before the final oral examination;
- Notice must be given to the Graduate School at least two weeks before the exam and;
- Must see the Graduate Staff Assistant to complete a form and schedule the exam.

The comprehensive examination consists of written and oral parts. The written part includes preparation of a Comprehensive Paper which details the research plan to be conducted, methods and proposed approach. The paper should include the following: abstract, introduction, literature review, dissertation research proposal, summary of the research performed to date, detailed research plan to complete research with time-table, and conclusions with summary of the envisioned original contributions. The paper should be provided to the doctoral committee at **least two weeks** before the exam. The oral part consists of the presentation of Comprehensive Paper and answers to questions of the PhD committee. These questions can relate both to the research and to general topics of nuclear engineering. The exam is given and evaluated by the entire doctoral committee. A favorable vote of at least two-thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine whether the candidate may retake the examination.

If a period of eight years has elapsed between the passing of the comprehensive examination and the completion of the program, the student is required to pass a second comprehensive examination before the final oral examination can be scheduled.

Continuous Registration

After a Ph.D. candidate has passed the comprehensive examination and met the two-semester full-time residence requirement, the student must register continuously for each fall and spring semester (beginning with the first semester after both of these requirements have been met) until the Final Oral Exam is passed and the Ph.D. thesis is accepted and approved by the doctoral committee. <http://bulletins.psu.edu/graduate/degreerequirements/degreeReq2> Post-comprehensive Ph.D. students can maintain registration by registering in the usual way, or by registering for noncredit 601 or 611, depending upon whether they are devoting full-time or part-time to thesis preparation. Students may take 601 plus up to 3 additional credits of course work for audit by paying only the dissertation fee. Students wishing to take up to 3 additional credits of course work for credit, with 601 may do so by paying the dissertation fee and an additional flat fee. Students who want to combine course work with thesis preparation must register for 600 or 611 (not for 601, which is full-time thesis preparation). Note that the least expensive way for a student to work full-time on research and thesis preparation is to register for 601.

Final Oral Examination/PhD Thesis Defense

Upon recommendation of the doctoral committee, a doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the Dean of the Graduate School to take a final oral examination. It is the responsibility of the doctoral candidate to provide a copy of the thesis to each member of the doctoral committee at least two weeks before the date of the scheduled examination.

Other requirements are as follows:

- The final oral examination may not be scheduled until at least three months have elapsed after the comprehensive exam was passed;
- Two-weeks' notice must be given to the Graduate School for scheduling;
- Must see the Graduate Staff Assistant to schedule this exam. There is a required form that must be completed;
- The deadline for holding exam in each semester is published in the Penn State calendar. A copy of this calendar can be obtained from the following web site <http://forms.gradsch.psu.edu/thesis/Calendar.pdf>
- The student must be registered full- or part-time during the semester in which the final oral exam is taken.

The final examination is an oral examination administered and evaluated by the entire doctoral committee. It consists of an oral presentation of the thesis by the candidate and a period of questions and responses. The examination is related largely to the thesis, but it may cover the candidate's whole field of study without regard to courses that have been taken either at this University or elsewhere. The defense of the thesis should be well-prepared including any appropriate visual aids. The portion of the exam in which the thesis is presented is open to the public.

A favorable vote of at least two-thirds of the committee is required for passing. If a candidate fails, the committee will determine whether another examination may be taken later.

Summary of Ph.D. Degree Requirements

It is the student's responsibility to ensure that all requirements have been met in a timely manner. Please read carefully the section of this manual titled *Academic Policies*.

Requirement	Person Responsible	Suggested Completion Date
Assign a faculty member to serve as faculty advisor	Student	Early in first semester
Take Doctoral Qualifying examination	Ph.D. Qualifying Examination Committee to conduct the examination.	Normally, after two enrolled semesters or after earning 24 course credits beyond the baccalaureate degree.
Prepare thesis research area. (Thesis advisor and chairman)	Student	Beginning of first semester after completing Qualifying examination.
Recommend faculty members to serve on doctoral committee	Thesis Chairman. Student to see Graduate Staff Assistant to complete appointment paperwork.	Beginning of first semester after completing Qualifying examination.
Complete written and oral comprehensive examinations	Student to schedule exams through Graduate Staff Assistant	Upon substantial completion of course work.
Apply for Graduation on Lionpath	Student	Prior to the Graduate School's deadline date*
Submit draft copy of thesis to faculty advisor.	Student	Early in last semester
Distribute draft copies of thesis to each committee member and Program Chair.	Student	After the thesis has been approved by faculty advisor.
Submit a complete draft of the thesis to the Thesis Office for a format review	Student	Prior to the Graduate School's deadline date*
Complete final oral examination	Student notifies the Graduate Staff Assistant to complete the necessary paperwork.	As soon as faculty advisor approves thesis for oral examination. Early enough for final draft of thesis to be submitted before deadline date.
Submit final, corrected, thesis to Graduate School by eTD	Student	Prior to the Graduate School's deadline date*
Provide one hardbound copy of thesis to faculty advisor.	Student	Prior to departure
Completion of paper for submission to a refereed periodical	Student	Prior to departure
Return keys and any books, software, supplies, etc. to Nuclear Engineering.	Student	Prior to departure

*Every semester the Graduate School produces a calendar of graduation deadlines and is posted on at <http://www.gradschool.psu.edu/current-students/etd/thesisdissertationperformance-calendar/>.

SCHOLARSHIP AND RESEARCH INTEGRITY (CITI & SARI RCR)

Based on guidance provided by the Council of Graduate Schools in a report entitled “Graduate Education for the Responsible Conduct of Research (RCR),” the Scholarship and Research Integrity (SARI) program is an opportunity to engage graduate students broadly in a dialog surrounding issues pertinent to research ethics. The SARI program has two parts.

- SARI RCR (Responsible Conduct of Research) portion of SARI – complete during first year
- CITI (Collaborative Institutional Training Initiative) – complete during first semester

SARI RCR Overview

Every student must complete 5 hours of discussion-based SARI RCR (Responsible Conduct of Research) education during his/her first year. SARI RCR hours can be earned by completing: ME 590 SARI module, attending SARI ORP events (2 hours max.), and/or SARI modules on Canvas. CITI online does not count toward the 5 hours of SARI RCR.

Not sure what you need to do to complete SARI?

If you have any questions, ask us by emailing ars6543@psu.edu.

CITI On-line Training

All graduate students in NUCE are required to complete the on-line CITI training program for **engineering** within their first semester. Completion of the CITI program will result in a certificate of completion. Failure to comply will preclude certification for graduation by the Department.

1. Go to <http://citi.psu.edu/>
2. Select “Log in to CITI” under University Park
3. Enter your PSU credentials. (If this does not work, go to <https://www.citiprogram.org/> instead, and create a username and password to access the CITI online training.)
4. Select the course called “Responsible Conduct of Research (RCR) – Basic”
5. Remember to email the certificate to after completing the course.

Facilities

The Radiation Science & Engineering Center (RSEC)

The RSEC facilities include the Penn State Breazeale Reactor, gamma-ray irradiation facilities (in-pool irradiator and dry irradiator), the Neutron Beam Laboratory, the Hot Cell Laboratory, the Radionuclear Applications Laboratory, the Radiochemistry Teaching Laboratory, the Nuclear Security Education Laboratory, the Subcritical Graphite Reactor Facility, and various radiation detection and measurement laboratories

TRIGA Reactor

The TRIGA reactor system at the RSEC is a versatile reactor operating at a power level of 1 MW with a maximum thermal neutron flux of 2.7×10^{13} neutrons/cm²-sec and can be pulsed to a peak power of 2000 MW with a maximum integrated output of 6×10^{16} neutrons/cm². The reactor core, suspended from a movable bridge, can be positioned in the “swimming pool” to provide the most effective experimental setup. Special equipment directly associated with the reactor includes a D₂O thermal column, pneumatic “rabbit” tubes, several beam ports, and a traversing experimental rig. The reactor normally operates one shift per day, five days a week. More information is at <https://www.rsec.psu.edu/>

Neutron Beam Laboratory

The Neutron Beam Laboratory (NBL) is one of the most used facilities at the RSEC. Well-collimated beams of neutrons, thermalized by D₂O, are passed into the NBL for use in various neutron beam techniques. When the reactor core is placed next to the D₂O tank and graphite reflector assembly near the beam port locations, thermal neutron beams become available for neutron transmission and neutron radiography measurements from two of the seven existing beam ports.

The RSEC has a facility specifically designed to measure the ¹⁰B concentration in neutron-absorbing materials and has been working in this field since 1998. The facility and the measurement method are used to characterize the effectiveness of most boron-based aluminum neutron-absorbing materials used by the nuclear industry. The neutron beam laboratory also houses a neutron imaging facility for the inspection of materials.

Nuclear Security Education Laboratory

The primary goal of this laboratory is to provide students with hands-on experience with radiation detection systems, sensors, devices, and source technologies. Students can become familiar with major radiation detectors/sensors and radiation sources, understand the principles of radiation interactions with matter, demonstrate an understanding of the principles of radiation detection and measurement, nuclear instrumentation, detectors/sensors, field deployable devices, portal monitors, dosimeters, and nondestructive and destructive assay methods, as well as demonstrate an ability to conduct experiments, acquire data, and analyze and interpret the data. The following experiments are designed and included in the course designed for the equipment in this laboratory: neutron multiplicity measurements, identifying the differences between neutron emissions from (a, n) reactions and spontaneous fission sources by use of neutron counting and neutron coincidence counting measurements, gamma-ray spectroscopy systems for versatile in-situ counting (identification of unknown radionuclides with various gamma spectroscopy systems), environmental media characterization (soil, air, water, etc.), alpha source activity determination, special nuclear materials gamma-ray spectroscopy analysis, measurement of ²³⁵U enrichment and quantity of uranium in a sample, Pu/U ratio analysis, Pu isotopic composition determination by gamma-ray spectroscopy, radiation counting of known source materials for counting statistics, precision and accuracy, and MDA determination, determinate corrections in radiation counting (absorption, backscatter, geometry considerations, detectors and supporting electronics), liquid scintillator detectors for pulse shape discrimination for neutron and gamma-ray sources, and absolute activity measurement using coincidence counting.

Radiochemistry Teaching and Research Laboratory

The RSEC recently created a new radiochemistry research laboratory. This wet chemistry laboratory is equipped with a radioactive materials capable fume hood, a HEPA-filtered inert atmosphere glove box for radiochemical use, and a suite of chemicals and laboratory materials for radiochemical applications. The radiochemistry teaching laboratory was created several years ago with funding from DOE – REAP and NRC curriculum development funds, and provides a space for undergraduate and graduate students to obtain hands on experience with essential radiochemical concepts and techniques for applications in radionuclide detection and separations, environmental studies, nuclear fuel reprocessing, and nuclear forensics.

Radionuclear Applications Laboratory (RAL)

The RSEC RAL provides technical assistance to research personnel and industrial users who need to use radionuclear techniques in their research. The laboratory houses four complete high-purity germanium detector systems with state-of-the-art electronics, multiple computer systems, and two automated sample changers. A Compton suppression system was added to enhance the sensitivity of measurements made in laboratory. A pneumatic tube transport system allows samples to be transported safely and quickly between the reactor core and the laboratory workstation

Cobalt-60 Gamma Ray Irradiation

The Radiation Science and Engineering Center has two gamma-ray irradiation facilities, which provide flexibility for research and industry projects. The Center has a pool irradiator with movable sources that can be configured to suit the researcher. Discrete neutron sources can be inserted in the pool to provide a mixed field. There is also a dry cell gamma irradiator that has a much higher dose rate for samples that require it. Using these two facilities, doses of kiloRads to GigaRads can be provided to the researcher.

Hot Cells

The RSEC Hot Cell Laboratory (HCL) houses two shielded enclosures for work with significant amounts of radioactive materials. The cells are capable of handling 100-350 curies of activity depending on the shielding configuration. Both cells have several access plugs including roof plugs to the reactor bay so samples can come from the reactor pool and into the cells without leaving a controlled area. The hot cells also have transfer capability from one cell to the other using the electro-mechanical manipulators. The cells are HEPA filtered and are kept at a negative pressure during use. The HCL has its own loading dock and crane system that can move casks directly from the cells onto a waiting truck.

Subcritical Graphite Reactor

The graphite sub-critical reactor facility (GSR) was constructed at Penn State in 1958 as part of a graduate student project. The pile was intended to expand upon the research reactor facility's capabilities to educate students in the burgeoning field of nuclear engineering. Since then, it has been used continuously for 55 years as part of the reactor physics curriculum. Currently the GSR is used as the basis for teaching subcritical physics to approximately 100 undergraduate students each year. Additionally, the facility is used by researchers who require a well-thermalized neutron field for their experiments. Recently, the facility has been used to develop sensitive neutron detectors for nuclear safeguards purposes

Course Descriptions

Updated Course Schedule can be found on [LionPATH](#) or at <http://launch.lionpath.psu.edu/>

Undergraduate (400 Level Courses)

403 ADVANCED REACTOR DESIGN (3) Physical principles and computational methods for reactor analysis and design. Multigroup diffusion theory; determination of fast and thermal group constants; cell calculations for heterogeneous core lattices. Prerequisite: NUCE 302.

405 (CHEM 405) NUCLEAR AND RADIOCHEMISTRY (3) Theory of radioactive decay processes, nuclear properties and structure, nuclear reactions, interactions of radiation with matter, biological effects of radiation. Prerequisites: PHYS 237 or CHEM 452 or NUCE 301.

408 RADIATION SHIELDING (3): Radiation sources in reactor systems; attenuation of gamma rays and neutrons; point kernel methods; deep penetration theories; Monte Carlo methods.

409 (MATSE 409) NUCLEAR MATERIALS (3) Nuclear reactor materials: relationship between changes in material properties and microstructural evolution of nuclear cladding and fuel under irradiation. Prerequisite: PHYS 203 or 204

420 RADIOLOGICAL SAFETY (3) Ionizing radiation, biological effects, radiation measurement, dose computational techniques, local and federal regulations, exposure control. Prerequisites: MATH 251, PHYS 237 or 265, or NUCE 301.

428 RADIOACTIVE WASTE CONTROL (3) Nature, sources, and control of radioactive wastes; theory and practice of disposal processes. Prerequisites: NUCE 301 or instructor permission.

430 DESIGN PRINCIPLES OF REACTOR SYSTEMS (3) Nuclear power cycles; heat removal problems; kinetic behavior of nuclear systems; material and structural design problems. Prerequisites: M E 412; NUCE 301 or 401.

431 NUCLEAR REACTOR CORE DESIGN SYNTHESIS (4) Technical and economic optimization of nuclear systems. Prerequisites: ENGL 202C; NUC E 403 and 430.

441 NUCLEAR SECURITY THREAT ANALYSIS AND ASSESSMENT (3) Nuclear threat assessment and analysis for non-state actors to nuclear and radiological facilities and supply lines. Prerequisite: NUCE 301

442 NUCLEAR SECURITY SYSTEM DESIGN (3) Science and engineering associated with the design, evaluation, and implementation of systems to secure nuclear and radiological materials. Prerequisite: NUCE 302

450 RADIATION DETECTION AND MEASUREMENT (3) Theory and laboratory applications of radiation detectors, including proton, neutron, charged particle detectors. NIM devices, and pulse-height analysis. Prerequisite: NUCE 301 or NUCE 405.

451 EXPERIMENTS IN REACTOR PHYSICS (3) Acquisition and processing nuclear and atomic data; application to nucleonic phenomena of importance in nuclear engineering. Prerequisites: NUCE 450, E E 305.

460 NUCLEAR SYSTEMS RISK ASSESSMENT (3) Probability concepts and distributions, failure data, reliability and availability of simple systems, fault and event tree analysis, risk concepts, nuclear power risks, WASH-1400. Prerequisite: NUCE 309 or STAT 401.

470 POWER PLANT SIMULATION (3) Basic knowledge necessary for intelligent simulation and interpretation of simulations of transients in nuclear power plants. Prerequisite(s): ME 33, MATH 251, NUCE 302

490 (AERSP 490, EE 490) INTRODUCTION TO PLASMAS (3) Plasma oscillations; collisional phenomena; transport properties; orbit theory; typical electric discharge phenomena. Prerequisite: EE 361 or PHYS 467.

497 FUNDAMENTALS OF NUCLEAR ENGINEERING (3) An intensive course providing introduction to NUCE to undergraduate co-op students, non-NucE graduate, and returning students.

Graduate (500 Level Courses)

501 REACTOR ENGINEERING (3) Thermal hydraulic fundamentals including thermal hydraulic characteristics of power reactors, thermal design principles, reactor heat generators, thermal analysis of fuel elements and size and two-phase heat transfer in heated channels. Prerequisites: NUCE 302; NUC E 430

502 REACTOR CORE THERMAL-HYDRAULICS (3) In-depth analysis of the thermal hydraulic design in LWRs. Topics include: LWR design criteria, fuel rod design, subchannel analysis, uncertainties analysis, and system design. Prerequisite: NUCE 501

505 REACTOR INSTRUMENTATION AND CONTROL (3) Reactor control principles; classical control methods; operational control problems; control simulation using modern mainframe and microcomputer software packages; reactor instrumentation. Prerequisite: NUC E 302 or NUCE 401

511 NUCLEAR REACTOR KINETICS AND DYNAMICS (3) Analytical kinetics and dynamics modeling for reactivity-induced transients, applications including reactor accident kinetics methods for simple and complex geometries, experimental methods.

512 NUCLEAR FUEL MANAGEMENT (3) Develop advanced techniques for reloading nuclear reactors using sophisticated neutronic codes. Emphasis on calculational techniques in reactor optimization and design, and economic value through the fuel cycle. Prerequisite: NUCE 302.

521 NEUTRON TRANSPORT THEORY (3) Derivation of Boltzmann equation for neutron transport; techniques of approximate and exact solution for the monoenergetic and spectrum regenerating cases. Prerequisite: NUCE 403 or PHYS 406

523 ENVIRONMENTAL DEGRADATION OF MATERIALS IN NUCLEAR POWER PLANTS (3) covers the electrochemistry and materials aspect of the in-reactor degradation processes that affect materials performance. Uniform and localized cladding corrosion, stress-corrosion cracking irradiation creep and growth.

525 MONTE CARLO METHODS (3) Fundamentals of the probability theory and statistics, analog and non-analog Monte Carlo methods and their applications, random processes, and numbers. Prerequisite: CMPSC 201, MATH 141, NUCE 309 or STAT 401.

530 PARALLEL/VECTOR ALGORITHMS FOR SCIENTIFIC APPLICATIONS (3) Development/analysis of parallel/vector algorithms (finite-differencing of PDEs and Monte Carlo methods) for engineering/scientific applications for shared and distributed memory architectures. Prerequisites: AERSP 424 or CSE 457.

542 SOURCE AND DETECTOR TECHNOLOGIES FOR NUCLEAR SECURITY (3) Theory and technology behind detectors, sensors, and source technologies including portal monitors and field deployable detection systems. Prerequisite: NUCE 450

543 NUCLEAR SECURITY EDUCATION LABORATORY (3) Hands-on experience with the radiation detection systems, sensors, devices, and source technologies for nuclear security. Prerequisites: NUCE 450, NUCE 542

544 GLOBAL NUCLEAR SECURITY POLICIES (3) Reviews historical development and examines the current state of American and International policies and laws related to global nuclear security.

597 NUCLEAR AND PARTICLE PHYSICS FOR NUCLEAR SCIENCE (3) Fundamental forces, elementary particles, the Standard Model and beyond, nuclear decay and reactions, quantum theory. Prerequisites: NUCE 403, NUCE 450

See also the seminar and thesis courses on pages 6 and 7.

Faculty Research Interests

The Department actively conducts research to generate new knowledge that will strengthen and support undergraduate and graduate education at Penn State, in the United States, and the World. More information on each of our research areas can be found at: <https://www.nuce.psu.edu/research/index.aspx>

TO MAKE A REPORT

A summary of types of misconduct and how to report is available at <http://reporting.psu.edu>

Crime or emergency situation

- Contact the campus police (814-863-1111) or security office
- In an emergency, dial **911**

If at any point you are unsure where to report a non-emergency, you may contact:

- The Office of Ethics and Compliance, Monday-Friday, 8am-5pm ET: 814-867-5088
- The Penn State Hotline, 24/7: 800-560-1637 or <http://hotline.psu.edu>

Penn State has established a [Responsible Action Protocol](#) in response to the University Park Undergraduate Association's campaign for a medical amnesty policy. Effective January 2018, the Responsible Action Protocol was updated and now reflects the following:

- A student who acts responsibly by notifying the appropriate authorities (e.g. calling 911, alerting a resident assistant, contacting police) AND meets one or more of the following criteria typically will not face University conduct action for his or her own use or possession of alcohol or drugs. However, the student will be required to attend an approved alcohol or drug education program, such as BASICS or the Marijuana Intervention Program (MIP); the fee will be waived. When the student's behavior involves other Code of Conduct violations (e.g., vandalism, assault, furnishing to minors) the additional behavior may be subject to conduct action. If a student exhibits a pattern of problematic behavior with alcohol or drugs, that student may be subject to conduct action.
- The criteria which invoke the Protocol are:
 - A student seeks medical assistance *for himself or herself* when experiencing an alcohol or drug overdose or related problems
 - A student seeks medical assistance *for a peer* suffering from an alcohol or drug overdose or related problems
 - A student suffering from an alcohol or drug overdose or related problems, *for whom another student seeks assistance* will also not be subject to conduct action for alcohol violations.

Suspected ethical or policy violations

(including fraud, theft, conflict of interest, abusive or intimidating behavior, retaliation, athletics integrity or NCAA compliance)

- Report employee misconduct to your supervisor or [HR Strategic Partner](#)
- Report student misconduct to the [Office of Student Conduct](#) or call **814-863-0342**
- Use the Penn State Hotline at <800-560-1637> or <http://hotline.psu.edu>. Both are anonymous and available 24/7

Child abuse, including child sexual abuse

- Contact the Pennsylvania Child Welfare Services "ChildLine" at <800-932-0313> or <https://www.compass.state.pa.us/ewis>
- If the child is in immediate danger, dial **911** first
- You must also email AD72@psu.edu communicating that a report has been made. For more information on AD72 (Reporting Suspected Child Abuse), see <https://guru.psu.edu/policies/AD72.html>
- Further details can be found in the "Building a Safe Penn State: Reporting Child Abuse" training available on the Learning Resource Network at <http://lrn.psu.edu>

Behavioral threat

- Contact the Behavioral Threat Management Team at **855-863-BTMT (2868), 814-863-BTMT (2868)**, or <http://btmt.psu.edu/>

Bias, discrimination, or harassment

- To report behavior *by an employee*, contact the Affirmative Action Office at <814-863-0471>
- Visit the Report Bias website: <http://equity.psu.edu/reportbias> (For student reporting only)
- Acts of intolerance by students may be reported to the [Office of Student Conduct](#) at **814-863-0342**

Sexual harassment and other forms of sexual misconduct**

To make a report to the University:

- Contact the University's Title IX Coordinator at **814-867-0099** or titleix@psu.edu.

- **To file an online report:** Visit the Office of Sexual Misconduct Prevention and Response's website at <http://titleix.psu.edu/filing-a-report/> to file an online report
- **To file an anonymous report:** The Penn State Hotline is available 24/7 at [800-560-1637](tel:800-560-1637) or <http://hotline.psu.edu>. Both are anonymous and available 24/7.

**** Additional information regarding information and resources available in relation to incidents of sexual harassment and/or misconduct (including a campus-specific list of victim support services and confidential reporting options) can be found at <http://titleix.psu.edu/>**

To file a discrimination or harassment complaint outside of the University:

- The Office for Civil Rights (Philadelphia Office) at [215-656-8541](tel:215-656-8541) or email OCR.Philadelphia@ed.gov
- The Equal Employment Opportunity Commission (Philadelphia District Office) at [800-669-4000](tel:800-669-4000)
- The Pennsylvania Human Relations Commission (Harrisburg Regional Office) at [717-787-9780](tel:717-787-9780)

Student misconduct

- Contact the Office of Student Conduct at [814-863-0342](tel:814-863-0342) or <http://studentaffairs.psu.edu/conduct> or report at https://pennstate.qualtrics.com/jfe/form/SV_8qYxyWYciWERPGI
- Hazing by any student organization or individual is against Penn State's code of conduct, and also a violation of Pennsylvania law. To report instances of hazing within any student organization or group, including fraternities and sororities, contact the Office of Student Conduct (<http://studentaffairs.psu.edu/conduct> or [814-863-0342](tel:814-863-0342)) or the Penn State Hotline at [800-560-1637](tel:800-560-1637) or <http://hotline.psu.edu>

Research-related

- Any research-related concerns should be directed to the Office for Research Protections at [814-865-1775](tel:814-865-1775) or orp@psu.edu
- Research misconduct concerns should be directed to [814-865-1775](tel:814-865-1775) or researchconcerns@psu.edu

RESOURCES

- Policy AD88 - [Code of Responsible Conduct](#)
- By-laws of The Pennsylvania State University (section 8.13): <http://news.psu.edu/story/143476/2013/01/04/employees-reminded-disclose-conflicts-interest>
- Policy HR91 – Conflict of Interest: <https://guru.psu.edu/policies/OHR/hr91.html>
- Policy RP02 - Addressing Allegations of Research Misconduct: <https://guru.psu.edu/policies/RP02.html>
- Policy RP06 – Disclosure and Management of Significant Financial Interests: <https://guru.psu.edu/policies/RA20.html>
- Policy AD74 - Compliance with Clery Act: <https://policy.psu.edu/policies/ad74>
- Policy AD77 - Engaging in Outside Professional Activities (Conflict of Commitment): <http://guru.psu.edu/policies/AD77.html>
- Policy AD85 - Sexual and/or Gender-Based Harassment and Misconduct (including Sexual Harassment, Sexual Assault, Dating Violence, Stalking, and Related Inappropriate Conduct): <https://guru.psu.edu/policies/AD85.html>
- Policy AD86 – Acceptance of Gifts and Entertainment: <https://guru.psu.edu/policies/AD86.html>
- Policy AD91 - Discrimination and Harassment and Related Inappropriate Conduct: <https://guru.psu.edu/policies/AD91.html>

If it is not clear where to turn for assistance, any of these offices will guide you to someone who can help:

- Office of Human Resources Employee Relations Division at [814-865-1412](tel:814-865-1412) or <http://ohr.psu.edu/employee-relations/>
- Office of University Ethics and Compliance at [814-867-5088](tel:814-867-5088) or <http://www.universityethics.psu.edu/>
- Office of Affirmative Action at [814-863-0471](tel:814-863-0471) or <http://www.psu.edu/dept/aaoffice/>
- Office of Sexual Misconduct Prevention and Response at [814-867-0099](tel:814-867-0099) or titleix@psu.edu
- Office of Student Conduct at [814-863-0342](tel:814-863-0342) or <http://studentaffairs.psu.edu/conduct>
- Office of Internal Audit at [814-865-9596](tel:814-865-9596) or <http://www.internalaudit.psu.edu/>
- Clery Act Compliance Manager at [814-863-1273](tel:814-863-1273) or <http://www.police.psu.edu/clery/>
- Your campus, college, or unit's Human Resources [Strategic Partner](#). Contact information is available at <http://ohr.psu.edu/content/hr-strategic-partner-and-consultant-directory>