# 2015-2016 GRADUATE STUDENT HANDBOOK

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Welcome to the Nuclear Engineering Program at Penn State. We hope your experience with us will be a very valuable and rewarding one, and will contribute to your personal and professional development. Nuclear Engineering is a challenging and rewarding major, and in your graduate research and course work 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. Finally, as a high-quality research university, Penn State has many resources outside the program and the department that can serve to your benefit. We encourage you to seek out these opportunities to take full advantage of your time at Penn State.

Most of you will be faced with new situations involving changes in housing, lifestyle, community, faculty, student body and academic policies. In some cases, it will represent a complete change in culture and language. We will try to help you to get through this time of transition. The staff has experience in helping with many academic issues such as registration, locating a desk, computer policies and financial aid. Also, the continuing graduate students are a very useful source of information about the community and the University. We have prepared this handbook to help deal with some of these issues. It includes detailed information about policies, and about the Radiation Science and Engineering Center. It also contains a brief discussion of our faculty and their interests. We urge you to review this document carefully and keep it available for reference.

Nuclear Engineering may be taken as a major field of study for the Master of Science (thesis or paper), the Master of Engineering, or the Doctor of Philosophy degree. New students should go to the Nuclear Engineering Graduate Staff Assistant, in 127 Reber Building, for the assignment of an academic advisor. Your advisor will assist you in the development of your program of study. Each student's program of study will be tailored with regard to their particular interest. Initially, your academic advisor may or may not be your research advisor depending on your research area of interest. Generally your research advisor takes over as the academic advisor when your research activity is determined. It is now a requirement that you complete a plan of study with your academic advisor during your first month of enrollment, covering your whole course of study. This program of study will be kept on file and can be changed with the approval of your advisor. To assure that you can meet with your advisor and discuss your academic program, please make an appointment prior to the desired meeting time.

The course registration process is relatively simple. You register on-line at www.elion.psu.edu. However, if you experience difficulties, contact the Graduate Staff Assistant. Any questions concerning registration procedures, dates and schedules should also be directed to the Graduate Staff Assistant. Your registration should always be in consultation with your advisor. For issues dealing with office keys, contact the Business Office in 132 Reber Building. An office area and desk can be assigned for your use if one is available. See the Graduate Staff Assistant in 127 Reber Building during the third week of the semester for their location.

Completion of a graduate degree program inevitably involves far more work near the end of the program than is anticipated. As a consequence, many students are unduly rushed just prior to their graduation to complete their scholarly paper, thesis, or M. Eng. paper. A student may have to delay graduation if there is not sufficient time for review and defense of the thesis, paper, or M. Eng. paper. Your advisor and the Program Chair must receive a copy of your paper or thesis at least one week (two weeks is better) before it is due in the Graduate School (Kern Building).
We would like to call your attention to the bulletin boards that are maintained in Reber Building and in the main hallway at the Reactor. Please scan the bulletin boards occasionally for announcements of importance to you, such as seminars, course offerings, and social events. You are assigned a mailbox located in 127 Reber which will serve as your contact point for mail, notices and other information periodically distributed. This is one of our main communication routes to you; check it when you pass through. Our other main way to contact you is via e-mail. You are assigned an e-mail address when you join Penn State. Please check it often at one of the computer labs. You can also access it at home if you have a computer by using software furnished by the Center for Academic Computing (CAC), located in 2 Willard Building.

All graduate students in the Nuclear Engineering Program are required to participate in the seminar program, NucE 590 Colloquium, which includes seminars by graduate students, faculty and outside speakers. These seminars form an important part of your program and will provide you with instruction not only by your fellow students and our faculty, but also by prominent people in the nuclear engineering field.

A word about our local chapter of the American Nuclear Society (ANS) is appropriate here. Our student chapter 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 strongly recommend that you consider joining the chapter and actively support it. For more information, visit: http://php.scripts.psu.edu/clubs/up/ans/index.php or contact Dr. Marek Flaska mxf5309@psu.edu. Likewise, I 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. In addition, the MNE Graduate Program Office will be glad to assist you on any matter. Please make an appointment with my assistant, in 138 Reber Building. I would also be glad to meet with you to discuss any issues. Again, welcome to Penn State.

Dr. Arthur Motta

Professor and Chair of Nuclear Engineering
Academic Policies

Registration

Registration as a full-time student is required for each student receiving assistantship support. Full-time status is defined as:

<table>
<thead>
<tr>
<th>Appointment</th>
<th>Fall/Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-time assistantship</td>
<td>9-14 credits/semester</td>
<td>5-7 credits</td>
</tr>
<tr>
<td>1/2-time assistantship</td>
<td>9-12 credits</td>
<td>4-6 credits</td>
</tr>
<tr>
<td>3/4-time assistantship</td>
<td>6-8 credits</td>
<td>3-5 credits</td>
</tr>
</tbody>
</table>

Students holding fellowships, traineeships, or other awards based on academic excellence are required to carry 9 or more credits each semester and 5 or more during the summer session.

Each graduate student is required to register for each fall and spring semester until all degree requirements are completed. However, if all degree requirements (including thesis defense and thesis submission) are completed prior to the first day of classes of the semester in which the student will be graduating, then the student is not required to register for that semester. For example, if a student is planning to graduate at the end of fall semester, then all degree requirements (including thesis defense and thesis submission) must be completed prior to the first day of class or the student must register for the appropriate number of credits for the semester.

Courses that may be used to meet continuous registration requirements are:

NucE 600/610 If full-time status does not need to be maintained, the student should register for the appropriate number of thesis credits which accurately reflects the amount of research being done on the thesis (number of credits to be determined in consultation with student's advisor). NucE 600 is for students who will be on campus; NucE 610 is for students who will be off campus.

NucE 601/611 This special registration may be used only by Ph.D. students starting with the semester after the comprehensive examination is passed and only if the two-semester residence requirement has been met. If a student must maintain full-time status for an assistantship, fellowship, etc., NucE 601 would be an appropriate registration. NucE 611 is the appropriate course for a part-time Ph.D. student. To register for NucE 601, students must be devoting their efforts entirely to thesis research/writing (i.e. no courses). These courses do not carry academic credit. They only indicate the registration and the nature of the candidate's academic activity.
Administrative Policies

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.

As a result of action taken by the University Graduate Council, The AEOCPT is designed for the purpose of determining the extent to which a potential International Teaching Assistant (ITA) demonstrates a sufficient level of English language proficiency required to carryout the duties of a teaching assistant in his/her home department. The score an ITA receives on this test will determine when he/she may assume teaching duties as a teaching assistant.

The AEOCPT is administered directly prior to the start of each semester (in August, January, and May). The August testing occurs during the two weeks prior to the start of fall semester classes. Students who are selected for teaching assistantships will be registered for the AEOCPT test directly by the department.

<table>
<thead>
<tr>
<th>AEOCPT SCORE</th>
<th>REQUIRED COURSE</th>
<th>PROGNOSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>250-300</td>
<td>None</td>
<td>Student may assume teaching duties with no restrictions.</td>
</tr>
<tr>
<td>200-249</td>
<td>Enroll in ESL 118G before assuming teaching duties.</td>
<td>Students enrolled in ESL 118G must pass the qualifying exit examination, called the Interactive Performance Test (IPT), before they can assume teaching duties with no restrictions.</td>
</tr>
<tr>
<td>150-199</td>
<td>Enroll in ESL 117G</td>
<td>Will require at least two semesters before student is recommended to teach.</td>
</tr>
<tr>
<td>&lt;150</td>
<td>Enroll in ESL 115G</td>
<td>Will require at least three semesters before student is recommended to teach.</td>
</tr>
</tbody>
</table>

Expenses for Thesis Preparation and Manuscripts

*Expenses for thesis preparation, such as typing, word processing, drafting, paper, photocopying, etc., are considered personal expenses and should be paid by the student and not the Program* Expenses related to the preparation of required reports or publications based on theses or technical projects are considered legitimate Program expenses. Also, students are encouraged to participate with faculty in the preparation of grant proposals to obtain the necessary support for research activities. Secretarial services will be made available for preparation of reports required for grant research projects.

Office and Key Assignments

*DESKS* - Every effort will be made to provide all graduate students with desks. Since there are more graduate students than space available, priority will be given to students on assistantships. Students on teaching assistantships will be provided desks and meeting space so they can carry out their responsibilities as teaching assistants. Students on research assistantships will also be provided desks. Other graduate students will be allotted desks within the remaining available space. It may not be possible to provide all new graduate students with desks, although desks will be assigned in subsequent months as they become available.
KEYS - Keys are individually numbered and assigned to each person. If a change of assignment results in you no longer needing a key, return the key to the key custodian who assigned it to you (usually in the MNE Business Office in 132 Reber Building); do not pass it on to another individual. Access to Reber Building is gained by the use of the PSU student ID card.

Smoking Policy

For the consideration of health, comfort and safety of all people in Nuclear Engineering, SMOKING IN ANY FORM IS NOT ALLOWED IN ANY AREA of The Pennsylvania State University buildings, including hallways, lounges and restrooms.

Purchasing

All purchases of materials, supplies, equipment, or tickets for travel related to Nuclear Engineering Program research and teaching activities, must receive prior approval of the student’s advisor.

Use of University Vehicles

University vehicles are for OFFICIAL USE ONLY. Operators of University vehicles must abide by all state highway laws. Special courtesy to other drivers should be exercised at all times, since one is representing the Nuclear Engineering Program, the University and the Commonwealth when driving a University vehicle. No passengers are allowed to ride in any of these vehicles unless the passengers are authorized to participate in official business.

A valid Pennsylvania driver’s license is required to operate University vehicles, except that operation of vehicles heavier than 30,000 pounds gross requires a Class 2 license. A Class 3 license is required to drive a vehicle towing a trailer more than 10,000 pounds. Caution: Only persons employed by the University are covered by insurance while operating a University owned vehicle. A graduate student on an assistantship meets the employment criterion. Students operating University vehicles should check with their advisor concerning current procedures for signing out vehicles, purchase of fuel, etc.

Health Insurance

Penn State requires medical insurance for all international students, and for all dependents of international students.

Graduate assistants will be placed on the Penn State student insurance plan underwritten by Aetna Student Health. The University will pay 80 percent of the student’s premium and the remainder of the premium will be deducted from graduate assistants’ paychecks every month from September to May.

Students required to have health insurance may choose coverage other than Aetna Student Health; however, in order to be granted a waiver, alternate plans must meet certain criteria (the guidelines and waiver application are available through the Student Insurance Office, 302 Student Health Center. An application for a waiver must be received by early September each year. Otherwise, enrollment in Aetna Student Health is automatic for graduate assistants. Newly arriving international students without assistantships who do not purchase Aetna Student Health or apply for a waiver by early September will be withdrawn from school.

Additional information can be obtained from their website at: http://studentaffairs.psu.edu/health/services/insurance/
Obligations and Responsibilities of Graduate Students

A large number of graduate students are appointed as graduate assistants. They are assigned tasks in teaching, research, or other activities which are educationally significant.

The privileges and benefits as well as the obligations and responsibilities of graduate assistants are:

As a Graduate Student

A. Privileges and Benefits

1. Eligible for financial assistance (grant-in-aid, tuition waivers and stipend).
2. Eligible for services at the Student Health Center.
3. Eligible for participation in Accident and Sickness Insurance Plan of the Graduate Student Association.
4. Eligible to use Penn State Career Services (http://studentaffairs.psu.edu/career/).
5. Participation in the program of the Graduate Student Association.
6. Eligible to join undergraduate student organizations, except those whose constitutions limit membership to undergraduates.

B. Obligations and Responsibilities

1. Maintain scholarship satisfactory to department.
2. Make progress in degree program acceptable to department, which includes eighteen weeks of service each semester as a graduate assistant.
3. Assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School.
4. Forego other employment while a graduate assistant as required by the Graduate School.
5. Meet standards of conduct outlined by the Division of Student Affairs – Office of Student Conduct – Code of Conduct for Penn State students. Please go to the following website for details: http://studentaffairs.psu.edu/conduct/codeofconduct/.
6. Register for the appropriate number of courses/credits per semester.
8. Exercise the privileges and obligations of academic freedom.
A Note to Students About Reporting Resources

All members of the Penn State Community are asked to be mindful of their individual responsibility to keep the University a safe and ethical institution. The following resources are available for faculty, staff, students and others to report any suspected illegal or unethical conduct, and to seek assistance.

- **Reporting a crime**: Contact the campus police or security office. In an emergency, dial 911.

**Assistance for victims of sexual violence, sexual abuse or sexual harassment:**

- The Penn State Sexual Assault and Relationship Violence Hotline at 800-550-7575 (TIY 866-714-7177), available 24/7.
- The University-wide designated sexual harassment resource person for students: The Director of Center for Women Students at 814-863-2027, at [http://studentaffairs.psu.edu/womenscenter/](http://studentaffairs.psu.edu/womenscenter/) online.
- A list of sexual assault resources for each campus location: [http://studentaffairs.psu.edu/womenscenter/resources/ccsars.shtml](http://studentaffairs.psu.edu/womenscenter/resources/ccsars.shtml) online.

- **If a child is a victim of any kind of abuse, including sexual abuse**: Contact the Pennsylvania Child Welfare Services "ChildLine" at 800-932-0313.

- **Reporting ethical violations** (including fraud, theft, conflict of interest and violations of University policy, including research compliance, discrimination and athletics-compliance issues):
  - The Penn State Ethics and Compliance Hotline at 800-560-1637 or [http://www.mycompliancereport.com/brand/psu](http://www.mycompliancereport.com/brand/psu) online, both anonymous and available 24/7.
  - The Penn State Ethics website provides a listing of contacts at [http://www.universityethics.psu.edu/contact_us.shtml](http://www.universityethics.psu.edu/contact_us.shtml) online.

- **The following University offices also are available**:
  - The Employee Relations Division of the Office of Human Resources at 814-865-1412.
  - The Office of Internal Audit at 814-865-9596.
  - College and administrative unit Human Resources Representatives listing at [http://ohr.psu.edu/hr-representatives](http://ohr.psu.edu/hr-representatives) online.
Master of Engineering

Admission Requirements

Completion of an undergraduate degree in Nuclear Engineering or in another related engineering or science discipline is required for admission to the M.Eng. 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.

Examinations for Admission

Test of English as a Foreign Language (TOEFL). To qualify for admission, an international student must achieve a minimum TOEFL score of 550 on the paper-based test, or a minimum score of 80 on the internet-based test with a minimum of a 19 in the speaking section. This requirement is waived if the student's native tongue is English or if the student received baccalaureate or master's degrees from an institution in which the language of instruction was English.

Graduate Record Examination (GRE). All students must submit scores on the general aptitude tests of the GRE prior to admission consideration.

Program Requirements

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.

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. At least six credits must be NucE 500-level courses.

5) Specific course requirements

a) NucE 301, 302, 403, 450 or their equivalent. Students with an undergraduate or graduate degree in Nuclear Engineering will usually have completed the equivalent of these courses. Some students may have the equivalent of NucE 403. You need to review this with your advisor. Students whose baccalaureate degree is not in nuclear engineering have two ways of fulfilling the undergraduate requirements. They can take NucE 497A, a three-credit reactor theory course, which is considered an acceptable substitute for NucE 301 and 302. NucE 403 is offered in residence and distance.
It is recommended that students who have not had reactor theory take Nuc E 403. If the student enters in the Fall Semester, NucE 301 must be taken in the Fall Semester and NucE 302 in the Spring Semester. Courses below the 400 level do not count toward the graduate program. The intention in the NucE 450 requirement is to make sure the entering student has had an adequate laboratory experience in (at least) radiation detection and measurement. An alternative to NucE 450 is NucE 497D (1cr) Radiation and Measurement Detection Lab which is offered biannually in a three day short course format.

6) No formal thesis is required; however, a professional paper is required for the M.Eng degree. Students take three (3) credits of Individual Studies in Nuclear Engineering, NucE 596, which represents formal recognition of the student's effort spent on writing a paper on an engineering subject. It must be approved by the advisor, a reader and the Program Chair.

7) 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.

Maintaining Satisfactory Scholarship

A minimum grade point average of 3.00 is required in order to be granted a graduate degree in Nuclear Engineering. In addition, at the end of the initial semester, a student with less than a 3.00 average will be notified by their faculty advisor of future grade point average requirements. These requirements will be developed by the graduate faculty early in the next semester. The Program will review each graduate student's grade point average at the end of each semester.

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.

If a student is dropped as a regular graduate student in Nuclear Engineering, continuing nuclear engineering study as a provisional student is possible. The student must be re-admitted into the Graduate School as a nondegree student. Such admission is subject to the recommendation of the Program Chair of Nuclear Engineering, who will act according to the recommendations of the Graduate Faculty developed in (c) above. During nondegree student status, no research credit (NucE 596 may be earned). 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. A maximum of 15 graduate-level credits earned while a nondegree student will be counted in satisfying the graduate degree requirements in Nuclear Engineering.
Summary of Master of Engineering 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.*

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Person Responsible</th>
<th>Suggested Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assign a faculty member to serve as faculty advisor</td>
<td>Student</td>
<td>Early in first semester or prior to choosing a paper topic</td>
</tr>
<tr>
<td>Establish a program of study</td>
<td>Student, with advisor approval</td>
<td></td>
</tr>
<tr>
<td>Activate your Intent to Graduate on E-Lion</td>
<td>Student</td>
<td>Prior to the Graduate School's deadline date*</td>
</tr>
<tr>
<td>Submit draft copy of engineering paper to faculty advisor</td>
<td>Student</td>
<td>Early in last semester</td>
</tr>
<tr>
<td>Contact the Graduate Secretary to initiate the submission of the</td>
<td>Faculty Advisor in conjunction with the Student</td>
<td>Prior to the Graduate School's deadline date*</td>
</tr>
<tr>
<td>Submit final copy of engineering paper to Program Chair</td>
<td>Student</td>
<td>Prior to the Graduate School's deadline date*</td>
</tr>
<tr>
<td>Return keys and any books, software, supplies, etc. to Nuclear Engineering</td>
<td>Student</td>
<td>Prior to departure</td>
</tr>
<tr>
<td>Provide one copy of scholarly paper to advisor</td>
<td>Student</td>
<td>Prior to graduation</td>
</tr>
</tbody>
</table>

*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/](http://www.gradschool.psu.edu/calendars/important-dates/)
Master of Science

Admission Requirements
Completion of an undergraduate degree in Nuclear Engineering or in another related engineering or science discipline is required for admission to the M.S. 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.

Examinations for Admission
Test of English as a Foreign Language (TOEFL). To qualify for admission, an international student must achieve a minimum TOEFL score of 550 on the paper-based test, and a minimum score of 80 on the internet-based test with a minimum of a 19 in the speaking section. This requirement is waived if the student's native tongue is English or if the student received a baccalaureate degree from an institution in which the language of instruction was English.

Graduate Record Examination (GRE). All students must submit scores on the general aptitude tests of the GRE prior to admission consideration.

Program Requirements
Each of the following requirements must be met in order for the 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 of 3.00 is required, not counting grades obtained in NucE 600, Thesis Research.

3) At least twelve (12) 400- or 500-level course credits must be taken as NucE courses.

4) At least twelve (12) of the 30 required credits must be in 500-level courses. This includes any 500-level NucE courses taken to satisfy requirement #3 above. At least six of these credits must be NucE 500-level courses.

5) Specific course requirements
   a) NucE 301, 302, 403, 450 or their equivalent. Students with an undergraduate or graduate degree in Nuclear Engineering will usually have completed the equivalent of NucE 301, 302, and 450. Some students may have the equivalent of NucE 403. You need to review this with your advisor. Students whose baccalaureate degree is not in nuclear engineering have two ways of fulfilling the undergraduate requirement. If they enter in the Summer Session, they take NucE 497A, a three-credit reactor theory course, which is considered an acceptable substitute for NucE 301 and 302. The student can then proceed to NucE 403 in the Fall Semester. It is recommended that students who have not had reactor theory follow this path. If the student enters in the Fall Semester, NucE 301 must be taken in the Fall Semester and NucE 302 in the Spring Semester. Courses below the 400 level do not count toward the graduate program. The intention in the NucE 450 requirement is to make sure the entering student has had an adequate laboratory experience in (at least) radiation detection and measurement.
b) NucE 596 (Individual Studies) courses can be used in special circumstances to fulfill part of the graduate degree requirements. This requires special approval by the Nuclear Engineering Graduate Faculty, for which a petition must be submitted.

The petition must state clearly:
- the rationale for taking the Individual Studies course, rather than regular courses,
- the program of study defining the content of the course and the work to be performed by the student in taking the course, and
- the grading criteria whereby the student's work will be assessed.

The petition must be submitted by the end of the first week of class of the semester in which the course is to be taught. The graduate faculty will evaluate the petition and render a decision by the second week of classes. If the course is approved, the faculty member must document the student’s work and the grading in the student’s file.

No more than six (6) total credits of NucE 596 course may be applied toward the graduate degree.

6) There are two options for the M.S. degree. Requirements for the Thesis Option and the Non-Thesis Option follow:

a) Thesis Option - six (6) credits of thesis research, NucE 600, and the submittal of a thesis that meets the Graduate School requirements.

b) Non-Thesis Option - an additional six (6) credits, for a total of 18 credits, of 500-level courses and the submittal of a scholarly paper that must be approved by a faculty supervisor and the Program Chair.

7) 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.

Maintaining Satisfactory Scholarship

A minimum grade point average of 3.00 is required in order to be granted a graduate degree in Nuclear Engineering. In addition, at the end of the initial semester, a student with less than a 3.00 average will be notified by their faculty advisor of future grade point average requirements. These requirements will be developed by the graduate faculty early in the next semester. The Program will review each graduate student's grade point average at the end of each semester.

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 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) in 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.

If a student is dropped as a regular graduate student in Nuclear Engineering, continuing nuclear engineering study as a provisional student is possible. The student must be readmitted into the Graduate School as a nondegree student. Such admission is subject to the recommendation of the Program Chair of Nuclear Engineering, who will act according to the recommendations of the Graduate Faculty developed in (c) above. During nondegree student status, no research credit (NucE 600, 611) may be earned.
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. A maximum of 15 graduate-level credits earned while a nondegree student will be counted in satisfying the graduate degree requirements in Nuclear Engineering.

**Summary of Master of Science Degree With Thesis 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*.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Person Responsible</th>
<th>Suggested Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assign a faculty member to serve as faculty advisor</td>
<td>Student</td>
<td>Early in first semester</td>
</tr>
<tr>
<td>Establish a program of study</td>
<td>Student, with advisor approval</td>
<td>Within first month of enrollment in NucE grad program</td>
</tr>
<tr>
<td>Activate your Intent to Graduate on E-Lion</td>
<td>Student</td>
<td>Prior to the Graduate School’s deadline date*</td>
</tr>
<tr>
<td>Submit draft copy of thesis to faculty advisor</td>
<td>Student</td>
<td>Early in last semester</td>
</tr>
<tr>
<td>Submit a complete draft of the thesis to the Thesis Office for format review.</td>
<td>Student</td>
<td>Prior to the Graduate School’s deadline date*</td>
</tr>
<tr>
<td>Submit final, corrected, signed copy of thesis to the Thesis Office</td>
<td>Student</td>
<td>Prior to the Graduate School’s deadline date*</td>
</tr>
<tr>
<td>Return keys and any books, software, supplies, etc. to Nuclear Engineering</td>
<td>Student</td>
<td>Prior to departure</td>
</tr>
<tr>
<td>Provide one hardcover bound copy of thesis to advisor</td>
<td>Student</td>
<td>Prior to graduation</td>
</tr>
</tbody>
</table>

*Every semester the Graduate School produces a calendar of deadline dates regarding graduation and thesis approval. This calendar is posted on the Web at: [http://www.gradschool.psu.edu/current-students/etd/thesisdissertationperformance-calendar/](http://www.gradschool.psu.edu/current-students/etd/thesisdissertationperformance-calendar/).
Summary of Master of Science Degree Without Thesis Requirements

This option must be approved by the Chair of the Nuclear Engineering Program.

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.

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<th>Requirement</th>
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<th>Suggested Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assign a faculty member to serve as faculty advisor</td>
<td>Student</td>
<td>Early in first semester</td>
</tr>
<tr>
<td>Establish a program of study</td>
<td>Student, with advisor approval</td>
<td>Within first month of enrollment in NucE grad program</td>
</tr>
<tr>
<td>Activate your Intent to Graduate on E-Lion</td>
<td>Student</td>
<td>Prior to the Graduate School's deadline date*</td>
</tr>
<tr>
<td>Submit draft copy of scholarly paper to faculty advisor</td>
<td>Student</td>
<td>Early in last semester</td>
</tr>
<tr>
<td>Contact the Graduate Staff Assistant to initiate the submission of the Report of Master's Paper Draft Review</td>
<td>Faculty Advisor in conjunction with the Student</td>
<td>Prior to the Graduate School's deadline date*</td>
</tr>
<tr>
<td>Submit final copy of scholarly paper to the Program Chair.</td>
<td>Student</td>
<td>Prior to the Graduate School's deadline date*</td>
</tr>
<tr>
<td>Return keys and any books, software, supplies, etc. to Nuclear Engineering</td>
<td>Student</td>
<td>Prior to departure</td>
</tr>
<tr>
<td>Provide one hardcover bound copy of thesis to advisor</td>
<td>Student</td>
<td>Prior to graduation</td>
</tr>
</tbody>
</table>

*Every semester the Graduate School produces a calendar of deadline dates regarding graduation and thesis approval. This calendar is posted on the Web at: [http://www.gradschool.psu.edu/current-students/etd/thesisdissertationperformance-calendar/](http://www.gradschool.psu.edu/current-students/etd/thesisdissertationperformance-calendar/).
Doctor of Philosophy

Admission Requirements
The Program requirement for acceptance to graduate study toward a Ph.D. degree in Nuclear Engineering is a B.S. degree from an engineering or science program. The students considered for admission to the doctoral program in Nuclear Engineering are those whose background leads the faculty to believe they will succeed. Students are formally considered doctoral candidates after they have passed the candidacy exam.

Examinations for Admission
Test of English as a Foreign Language (TOEFL). To qualify for admission, an international student must achieve a minimum TOEFL score of 550 on the paper-based test, and a minimum score of 80 on the internet-based test with a minimum of a 19 in the speaking section. This requirement is waived if the student's native language is English or if the student received baccalaureate or master's degrees from an institution in which the language of instruction was English.

Graduate Record Examination (GRE). All students must submit scores on the general aptitude tests of the GRE prior to admission consideration.

Program Requirements
A doctoral program in Nuclear Engineering, as in all other disciplines at The Pennsylvania State University, consists of a collection of courses, seminars, and research that meets the minimum requirements of the Graduate School 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. Your program is to be worked out in consultation with your 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.

A student entering the Ph.D. program without an M.S. in NucE must meet the course requirements for an M.S. in NucE. Courses are: NucE 301, NucE 302, NucE 450, NucE 403 and six credits from NucE 500-level courses, but is to exclude NucE 596 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. In addition, at the end of the initial semester, a student with less than a 3.00 average will be notified by their faculty advisor of future grade point average requirements. These requirements will be developed by the graduate faculty early in the next semester. Nuclear Engineering will review each graduate student's grade point average at the end of each semester.

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 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) in 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.

If a student is dropped as a regular graduate student in the Nuclear Engineering Program, continuing nuclear engineering study as a provisional student is possible. The student must be readmitted into the Graduate School as a nondegree student. Such admission is subject to the recommendation of the Program Chair of Nuclear Engineering, who will act according to the recommendations of the Graduate Faculty detailed in (c) above. During nondegree student status, no research credit (NucE 600, 611) may be earned.

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. A maximum of 15 graduate-level credits earned while a nondegree student can be counted towards satisfying the graduate degree requirements in Nuclear Engineering.

**Candidacy Examination**

Early in the doctoral program, a student is required to be evaluated by the Nuclear Engineering Program’s Ph.D. Candidacy Examination Committee. A student who has been admitted to the Graduate School and has been accepted by the Nuclear Engineering Program may begin working toward the doctoral degree, but has provisional status as a doctoral student and no assurance that they will be accepted as a doctoral candidate until after the candidacy examination is passed. A candidacy examination can be taken after the student has had enough course work to prepare to solve the exam problems. For example, a student who has completed the Nuclear Engineering B.S. program could be ready to take the exam in the first or second semester of graduate work; whereas, other students may require 18 months of graduate course work in nuclear engineering. **Students are expected to take the candidacy examination after no more than 3 semesters (excluding summers) as a provisional doctoral student.** Students must be registered for the semester the candidacy exam is taken.

The evaluation of each student will be based on academic record, overall fitness for candidacy and a formal examination. The candidacy examination may include questions on all areas of basic engineering including: radiation protection, nuclear science, reactor physics, heat transfer, radiation detection, reactor kinetics, nuclear systems, radiochemistry, and computational methods.

The oral exam will be scheduled no sooner than one week following the written exam but as soon as practical thereafter. The full Committee and the student's advisor will participate with the option of the Candidacy Committee inviting additional graduate faculty members. The candidate's advisor will be asked to suggest documents to be the main topic for the oral exam. The topic is to be related to the candidate's field of interest but different from the thesis topic. The documents will be identified to the candidate one week before the oral exam. This requires that the signup period close two weeks before the written exam to allow the advisor and committee time to compile and review the documents.

If a Candidacy Committee member is the advisor to a student being examined, the Committee Chairman will ask another graduate faculty member to be added to the committee for that student's oral exam. If the Committee Chairman is advisor to a student being examined, the student will designate another Committee member as acting Chairman for the oral exam; the acting Chairman will, in turn, ask another graduate faculty member to serve on the Candidacy Committee.
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 admission to candidacy 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 candidacy examination was taken) as a registered, full-time student engaged in academic work at University Park.

Language and Communications Requirements

The Graduate School requires a high level of competence in the use of the English language. You will be given an English Proficiency Exam during your candidacy 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 must be formally attested before the doctoral comprehensive examination will be scheduled.

In addition to the Assessment program in coursework at the time of candidacy, 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. The Candidacy Committee and the student's advisor will certify whether adequate proficiency in the English language has been demonstrated based on the paper and the oral exam. A student may pass the candidacy 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 by taking a Speech Communication or English course. If the student has not demonstrated proficiency in English, the student will be admitted to candidacy and but a doctoral committee will not be appointed. Upon improvement of English skills, the student must write another paper, make a verbal presentation and respond to questions by the Candidacy Committee and advisor in the same manner.

The Doctoral Committee

The doctoral committee has the responsibility of giving the Comprehensive Examination and/or approving the doctoral thesis, both written thesis and the oral defense. The formation of the doctoral committee is governed by requirements of the Graduate School, which follow:

1) appointed soon after the student is admitted to the candidacy,
2) must include at least of four active members of the Graduate Faculty,
3) normally includes at least three faculty members from the Nuclear Engineering Program,
4) at least one regular member of the committee must be from outside Nuclear Engineering,
5) 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
6) 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 frequently includes additional members who can contribute technical advice regarding the research are included. External members, e.g., scientists at national laboratories, who are not at the University can be included as special members of a committee.

The doctoral committee is formed by the candidate with consultation between the candidate and main research advisor. It is advisable for the committee chair and the candidate to then schedule a committee meeting to review past and future course work in relation to the proposed area of research.
Comprehensive Examination

When a Ph.D. candidate has completed a substantial amount of the necessary course work, including the language and communication requirement, they will be required to take a comprehensive examination. The type of examination is determined by the doctoral committee but usually consists of a literature review and thesis proposal. Additional questions can cover the major and related areas of study. Requirements are as follows:

1) the student must satisfy the English Competence Requirement before taking the comprehensive.
2) must have a minimum grade point average of 3.00;
3) may not have deferred or missing grades;
4) must be registered full- or part-time for the semester in which the comprehensive is taken, including summers. Being registered for one credit of NucE 600 is sufficient;
5) the examination should be taken at least 3 months before the final oral examination;
6) must give at least two-weeks' notice to the Graduate School for scheduling, and;
7) must see the Graduate Staff Assistant to schedule the exam. There is a required form that must be completed.

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 have the following list of contents: 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 given to the 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 general topics of nuclear engineering. It 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 take another 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. 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. This clearly is the procedure of choice for international students who need to maintain status as full-time students for visa purposes.
Final Oral Examination

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:

1) The final oral examination may not be scheduled until at least three months have elapsed after the comprehensive exam was passed;
2) two-weeks' notice must be given to the Graduate School for scheduling;
3) must see the Graduate Staff Assistant to schedule this exam. There is a required form that must be completed;
4) the deadline for holding the exam is ten weeks before commencement. This date is listed in a calendar produced by the Thesis Office. A copy of this calendar can be obtained from the following web site http://forms.gradsch.psu.edu/thesis/Calendar.pdf
5) 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 at a later date.

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.

<table>
<thead>
<tr>
<th>Requirement</th>
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</thead>
<tbody>
<tr>
<td>Assign a faculty member to serve as faculty advisor</td>
<td>Student</td>
<td>Early in first semester</td>
</tr>
<tr>
<td>Complete doctoral candidacy examination</td>
<td>Ph.D. Candidacy Examination Committee to conduct the examination.</td>
<td>To be scheduled after a minimum of 18 course credits beyond the baccalaureate degree, but no later than two enrolled semesters after earning 24 course credits beyond the baccalaureate degree.</td>
</tr>
<tr>
<td>Prepare thesis research area. (Thesis advisor and chairman)</td>
<td>Student</td>
<td>Beginning of first semester after completing candidacy examination.</td>
</tr>
<tr>
<td>Task</td>
<td>Responsibility</td>
<td>Deadline</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Recommend faculty members to serve on doctoral committee</td>
<td>Thesis Chairman. Student to see Graduate Staff Assistant to complete appointment paperwork.</td>
<td>Beginning of first semester after completing candidacy examination.</td>
</tr>
<tr>
<td>Complete written and oral comprehensive examinations</td>
<td>Student to schedule exams through Graduate Staff Assistant</td>
<td>Upon substantial completion of course work.</td>
</tr>
<tr>
<td>Activate your Intent to Graduate on E-Lion.</td>
<td>Student</td>
<td>Prior to the Graduate School’s deadline date*</td>
</tr>
<tr>
<td>Submit draft copy of thesis to faculty advisor.</td>
<td>Student</td>
<td>Early in last semester</td>
</tr>
<tr>
<td>Distribute draft copies of thesis to each committee member and Program Chair.</td>
<td>Student</td>
<td>After the thesis has been approved by faculty advisor.</td>
</tr>
<tr>
<td>Submit a complete draft of the thesis to the Thesis Office for a format review</td>
<td>Student</td>
<td>Prior to the Graduate School’s deadline date*</td>
</tr>
<tr>
<td>Complete final oral examination</td>
<td>Student notifies the Graduate Staff Assistant to complete the necessary paperwork.</td>
<td>As soon as faculty advisor approves thesis for oral examination. Early enough for final draft of thesis to be submitted before deadline date.</td>
</tr>
<tr>
<td>Submit final, corrected, thesis to Graduate School by eTD</td>
<td>Student</td>
<td>Prior to the Graduate School’s deadline date*</td>
</tr>
<tr>
<td>Provide one hardbound copy of thesis to faculty advisor.</td>
<td>Student</td>
<td>Prior to departure</td>
</tr>
<tr>
<td>Completion of paper for submission to a refereed periodical</td>
<td>Student</td>
<td>Prior to departure</td>
</tr>
<tr>
<td>Return keys and any books, software, supplies, etc. to Nuclear Engineering.</td>
<td>Student</td>
<td>Prior to departure</td>
</tr>
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Scholarship and Research Integrity (SARI)

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.

1) During the first year of enrollment, all graduate students will be required to complete an online RCR training program provided by the Collaborative Institutional Training Initiative (CITI). The Office for Research Protections (ORP) will provide the link to this training via the SARI Resource Portal on the ORP website (http://www.research.psu.edu/orp/sari/). Graduate students will also be required to engage in an additional five hours of discussion-based RCR education prior to degree completion. These discussions will encompass both universal and discipline-specific material.

Effective Fall 2015, all incoming students are required to complete both SARI and CITI during the first two semesters of enrollment.

On-line training

Starting in Fall 2009, all new graduate students in MNE will be 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. Students will print out these certificates and submit them to the MNE graduate office. Failure to comply will preclude certification for graduation by the Department. Special exemptions may be granted for timing of completion, but all students must ultimately complete the on-line training.

Discussion-based training

Starting in Fall 2009, all new graduate students in MNE will be required to complete five hours of discussion-based SARI education. Compliance will be monitored by certificates issued to each student at each training event. Students will print out these certificates and submit them to the MNE graduate office. Failure to comply will preclude certification for graduation by the Department.

The five hours should consist of:

a) one or more hours as part of the MNE graduate seminar series
b) one to five hours provided on Angel under SARI Training, or
c) two hours provided by various ORP offerings (brown-bag seminars, special workshops).

The typical format for MNE, COE or ORP offerings will include short introductory lectures and/or case study presentations with breakout sessions either with the entire class, in small groups or in pairs; and a final closing session to summarize findings and opinions.
A non-comprehensive list of potential topics is provided below.

- Acquisition, management, sharing, and ownership of data
- Publication practices and responsible authorship
- Conflict of interest and commitment
- Research misconduct
- Professional and research ethics
- Peer review
- Mentor/trainee responsibilities
- Collaborative science
- Human subjects protections
- Government/industry interactions
- Lobbying
- Resisting political pressure over technical decisions
- Technology transfer
- ITAR requirements
- Globalization/cultural perspectives
- Bio-ethics
Facilities

The Radiation Science & Engineering Center (RSEC)

The RSEC is one of the most complete and modern university reactor facilities in the country. The laboratory complex contains a TRIGA Mark III reactor, the Cobalt-60 Radiation Facility, two hot cells, a radio-chemistry laboratory, a radio-nuclear applications laboratory, a natural uranium graphite subcritical reactor, a neutron radiography laboratory, a microprocessor and microcomputer laboratory, an electronics shop, a machine shop, an extensive array of radiation sources and counting equipment, and student classrooms.

TRIGA Reactor

The TRIGA reactor system at the RSEC is a most versatile and useful reactor operating at a power level of 1 MW with a maximum thermal neutron flux of $2.7 \times 10^{13}$ neutrons/cm$^2$-sec and can be pulsed to a peak power of 2000 MW with a maximum integrated output of $6 \times 10^{16}$ neutrons/cm$^2$. 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 D$_2$O thermal column, pneumatic “rabbit” tubes, several beam ports, and a traversing experimental ridge. The reactor normally operates one shift per day, five days a week.

Neutron Radiography Laboratory

Otherwise known as the RSEC Beam Hole Laboratory, this facility passes a well-collimated beam of neutrons from the reactor, thermalized by a D$_2$O thermal column, into the Center for use in nondestructive testing and evaluation. The major work now being done is utilizing a real time neutron image intensifier for real time radiography. This includes simulation of boron mixing in nuclear power plants using gadolinium and florinert. The beam is also being used for static neutron radiography and neutron attenuation studies. Equipment is available to digitize the real time radiography images for image processing.

Cobalt-60

In 1966, the University placed into operation a 3,200 square foot laboratory extension to its reactor facility. This two-level, gamma-ray laboratory houses about 5,000 curies of cobalt-60 in a 15,000-gallon pool of water. The radioactive cobalt-60, in the form of cobalt metal slugs contained in 150 stainless steel tubes, can be arranged in various configurations to meet the needs of the experimenter. Exposure rates up to $5 \times 10^5$ roentgens per hour are available and irradiation conditions such as controlled temperature, and instrumentation for experiments are possible. This facility is in around-the-clock use for a variety of radiation effects studies conducted by faculty members and students throughout the University.

Perturbed Angular Correlation Laboratory

Perturbed angular correlations spectroscopy is a type of a hyperfine measurement used to determine a change of state in a variety of materials, such as superconductors, ceramics and metals, as a function of experimental parameters. The apparatus in this laboratory is instrumented to detect hyperfine interactions that occur in the electric field in the region of the nucleus.

Nuclear Materials Laboratory

Located at the RSEC, this laboratory includes a positron annihilation lifetime spectrometer which is being used to monitor damage to pressure vessel steels. Facilities for sample preparation for electron microscopy are available, including electropolishing and arc melting. The laboratory also includes a Charpy impact tester and full hot cell facilities.
Hot Cells
To aid materials research and provide safe handling of many highly radioactive sources, the University has constructed two well-equipped hot cells at the RSEC. Each of these cells is capable of handling the equivalent of 100 curies of cobalt-60. Special shielding arrangements make possible experiments at an even higher level. Direct viewing of experiments through lead glass windows, remote manipulators, air cleaning equipment, utilities, and special control of waste materials all add to the capabilities of these hot cells.

Subcritical Reactor
A graphite, natural uranium subcritical reactor is used for student instruction. Five different lattice spacings can be set up with this subcritical reactor, allowing studies of heterogeneous arrays. Its unique construction permits all of the usual experiments associated with graphite reactor physics. Replacement of the fuel with graphite stringers provides a 6 x 6 x 9 foot graphite region for neutron slowing down and diffusion studies.

Radionuclear Applications Laboratory
Located at the RSEC, this laboratory is equipped with the latest in radiation detection equipment, including pulse height analyzers, GPGe, and NaI(Tl) radiation detectors. Personnel of this laboratory conduct research and offer other services to the University research community in the areas of neutron activation analysis, gamma-ray spectroscopy, tracer techniques, radiography, isotope gaging, and other applications of radiation and radioisotope technology.

Intelligent Distributed Control Research Laboratory (IDCRL)
The Penn State IDCRL was established in 1989. The original funding supplied the initial Bailey Control System. Equipment added later includes seven UNIX workstations, simulation and controls software, additional Bailey controller equipment and a modern state-of-the-art UNIX network compatible microprocessor-based control system. The equipment is used for advanced intelligent control research for fossil and nuclear power plants. This research includes validation using distributed real-time simulation of plant-wide power plant systems including boiler, feedwater turbine and generator subsystems and validation using the Penn State TRIGA research reactor. This laboratory is jointly used by faculty and students from the Mechanical and Nuclear Engineering Department and the Electrical Engineering Department that are conducting applied controls research involving implementation in a Bailey microprocessor-based distributed control system. The main part of the equipment is housed in 104 Electrical Engineering East Building. A portion of the equipment is also maintained at the Penn State Breazeale Reactor for those students conducting tests of advanced concepts on the reactor.

Low Pressure Integral Test Facility (LPITF)
The Penn State Nuclear Engineering Low Pressure Integral Test Facility (LPITF) is a unique, multipurpose, thermal hydraulic test loop. This test facility is made of two separate components with two separate objectives. These two components are the test loop and the boiling regime pipe. The test loop is designed to be an integral effects test facility, while the boiling regime pipe is a separate effects facility.

The study of natural circulation in a reactor system is a primary facility objective. This includes system behavior during startup, normal operation, and during accident scenarios. To this end, the test loop is a scaled version of the General Electric Simplified Boiling Water Reactor (SBWR). In addition to the modeling of the reactor core, chimney, and down comer, the test loop also models the emergency core cooling systems (ECCS) allowing for an integral effects study. Another design purpose is the study of boiling. The test loop instrumentation can be coupled with a computer and related software to allow for digital signal acquisition and control of various valves, heaters, and pumps.
The Advanced Multiphase Flow Laboratory (AMFL)

The facility is equipped with an air-water two-phase flow loop capable of investigating various geometric effects in comprehensive two-phase flow regimes, spanning from bubbly flow to annular flow. It is equipped with state-of-the-art two-phase flow instrumentation including a high-speed digital movie camera, ideal for flow visualization study, which is being employed in both undergraduate and graduate reactor thermal-hydraulics courses.

Intense Laser Laboratory (ILL)

ILL is a modern femtosecond laser facility that supports numerous projects in atomic, nuclear, and plasma physics and technology, accelerator technology, and nonproliferation applications. ILL is based on a terawatt Ti:sapphire laser system capable of producing relativistic intensities with arbitrary, programmable pulse shapes. The facility is equipped with state-of-the-art spectral, temporal and spatial diagnostics that supports a wide range of applications studied at several experimental stations.

PC Studio

In addition to the many student computer laboratories available throughout the University, there is a lab, located in 119 & 120 Reber specifically the Mechanical & Nuclear Engineering students. Access to the laboratory is by your Penn State ID.
Course Descriptions

Updated Course Schedule can be found at the Registrar’s website:  http://www.registrar.psu.edu/

Undergraduate 4xx Courses

403 ADVANCED REACTOR DESIGN (3:3:0) 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: NUC E 302.

405 (CHEM 405) NUCLEAR AND RADIOCHEMISTRY (3:3:0) 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 NUC E 301.

408 RADIATION (3:3:0) Attenuation of gamma rays and neutrons; point kernel methods; deep penetration theories; Monte Carlo methods. Prerequisite: NUC E 301.

409 (MATSE 409) NUCLEAR MATERIALS (3:3:0) 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 (3:3:0) Ionizing radiation, biological effects, radiation measurement, dose computational techniques, local and federal regulations, exposure control. Prerequisites: MATH 251, PHYS 237 or 265, or NUC E 301.

428 RADIOACTIVE WASTE CONTROL (3:3:0) Nature, sources, and control of radioactive wastes; theory and practice of disposal processes. Prerequisites: NUC E 301 or instructor permission.

430 DESIGN PRINCIPLES OF REACTOR SYSTEMS (3:3:0) Nuclear power cycles; heat removal problems; kinetic behavior of nuclear systems; material and structural design problems. Prerequisites: M E 412; NUC E 301 or 401.

431W NUCLEAR REACTOR CORE DESIGN SYNTHESIS (4:4:0) Technical and economic optimization of nuclear systems. Prerequisites: ENGL 202C; NUC E 403 and 430.

444 NUCLEAR REACTOR OPERATIONS LABORATORY (1:0:3) Correlation of reactor Prerequisite: NUC E 302.

450 RADIATION DETECTION AND MEASUREMENT (3:2:3) Theory and laboratory applications of radiation detectors, including proton, neutron, charged particle detectors. NIM devices, and pulse-height analysis. Prerequisite: NUC E 301 or NUC E 405.

451 EXPERIMENTS IN REACTOR PHYSICS (3:1:4) Acquisition and processing nuclear and atomic data; application to nucleonic phenomena of importance in nuclear engineering. Prerequisites: NUC E 450, E E 305.
460 NUCLEAR SYSTEMS RISK ASSESSMENT (3:3:0) 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: NUC E 309 or STAT 401.

470 POWER PLANT SIMULATION (3:2:2) Basic knowledge necessary for intelligent simulation and interpretation of simulations of transients in nuclear power plants. Prerequisite(s): ME 33, MATH 251, NUC E 302

490 (AERSP 490, E E 490) INTRODUCTION TO PLASMAS (3:3:0) Plasma oscillations; collisional phenomena; transport properties; orbit theory; typical electric discharge phenomena. Prerequisite: E E 361 or PHYS 467.

497A FUNDAMENTALS OF NUCLEAR ENGINEERING (3:3:0) An intensive course providing introduction to NucE to undergraduate co-op students, non-NucE graduate, and returning students.

**Graduate 5xx 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: NUC E 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: NUC E 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 NUC E 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: NUC E 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: NUC E 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, stresscorrosion 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, NUC E 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.

597D NUCLEAR REACTOR SAFETY (3) Covers the licensing process and analysis used for nuclear reactor safety. Topics include: federal regulations, accident classification and analysis, review of historical accidents, risk assessment, and advanced reactor design. Prerequisite: NUC E 501.

597E POWER PLANT DYNAMICS AND CONTROL (3) Mathematical foundation for modeling and analysis of dynamic behavior for electrical generating power plant components and systems; includes steam generation, feedwater, and turbine generator systems. Automatic control with single loop PID feedback and some conditioned feedforward signals.
Faculty Research Interests

**J. S. Brenizer, Jr.**  Professor of Nuclear Engineering; Ph.D., Penn State University. Radiation detection, neutron radiography, neutron activation analysis, nuclear test ban treaty monitoring, aerogel materials. (863-6384 or 865-6351), 229 Reber Bldg. or Nuclear Reactor, brenizer@engr.psu.edu.

**G. L. Catchen**  Professor emeritus of Nuclear Engineering; Ph.D., Columbia. Characterization of electronic, optical, magnetic materials, radiation detection/measurement, nonlinear regression/optimization, radiation dosimetry. (865-2011), 226 Reber Bldg., g9c@psu.edu.

**F. B. Cheung**  Professor of Mechanical and Nuclear Engineering; Ph.D., Notre Dame. Heat transfer, thermal systems. (863-4261), 304 Reber Bldg., fxc4@psu.edu.

**M. Flaska**  Assistant Professor of Nuclear Engineering; Ph.D., Delft University of Technology. Nuclear detection and nonproliferation, Monte-Carlo code development, imaging / characterization of two-phase flow. (867-4754), 227 Reber Bldg., mflaska@psu.edu.

**I. Jovanovic**  Associate Professor of Nuclear Engineering, Ph.D., University of California at Berkeley. Nuclear detection and nonproliferation, inertial confinement fusion, ultrafast and intense laser science and technology, remote sensing. (867-3609), 233 Reber Bldg., ijovanovic@psu.edu.

**S. Kim**  Associate Professor of Mechanical and Nuclear Engineering, Ph.D., Purdue University, Thermal-hydraulics and reactor safety, Multi-phase flow phenomena, Interfacial area transport, Geometric effects in two-phase flow transport, Development of two-phase flow instrumentation. (867-1783), 230 Reber Bldg., skim@psu.edu.

**S. H. Levine**  Professor emeritus of nuclear engineering – Fuel management, reactor operations, neutron spectrum and beta dosimetry measurements and calculations, reactor design, and fast reactor physics. (863-1653) 323 Reber Bldg. shl@psu.edu.
T. Lin
Senior Research Associate of Applied Research Laboratory, Ph.D., Rensselaer Polytechnic Institute - Thermal-hydraulics, critical heat flux and LOCA heat transfer, underwater propulsion and power, space reactors, lithium capillary cooling of Tokamak first wall. (863-4249), 260 ARL Bldg. ojdi@arl.psu.edu

A. T. Motta
Professor and Program Chair of Nuclear Engineering and Professor of Materials Science and Engineering; PhD., U. California at Berkeley. Corrosion of zirconium alloys, radiation damage and phase transformations under irradiation, mechanical behavior, transmission electron microscopy, synchrotron radiation. (865-0036) 227 Reber Bldg. atm2@psu.edu

G. E. Robinson
Professor Emeritus of Nuclear Engineering – Boiling heat transfer, reactor safety analysis, thermal-hydraulic modeling of nuclear power plants. (865-0045), 236B Reber Bldg. ger@psu.edu

B. E. Scheetz
Professor of Materials, Civil and Nuclear Engineering; Crystal chemistry; chemistry of cementitious systems including phase equilibria studies in cement phase assemblages, design of formulations in non-traditional cementitious systems; industrial ecology; waste management including large volume uses of industrial by-product; nuclear waste management including waste from design, stability, and waste/rock interactions, and performance of cements in nuclear applications; materials for environmental applications. (865-3539) 107 Materials Research Lab, se6@psu.edu

M. Tonks
Assistant Professor of Nuclear Engineering and Assistant Professor of Mechanical Engineering, Ph.D., University of Illinois at Urbana-Champaign: mesoscale computational approaches in predicting important phenomena related to nuclear fuel performance. mrt5296@psu.edu

K. Ünlü
Director of the Radiation Science and Engineering Center and Senior Scientist; Professor of Nuclear Engineering; Ph.D., U. Michigan. Development and Applications of Nuclear Analytical Techniques: Neutron Depth Profiling, Cold Neutron Prompt Gamma Activation Analysis, Neutron Radiography and Neutron Activation Analysis. (865-6351), Breazeale Nuclear Reactor, 231 Reber, Kxu2@psu.edu