2013

The Nuclear Engineering Program Handbook

For Students and Faculty

Department of Mechanical and Aerospace Engineering

Version 2

The Ohio State University
Updated Sept. 2013

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PREFACE

This handbook describes the policies and procedures of the Nuclear Engineering Program at The Ohio State University. It includes discussions of academic and examination requirements for both MS and PhD. programs. The MS and PhD. program requirements are consistent with those of the Graduate School. As the University transitions between the quarter system and the semester system in CY 2012, some special considerations may be required for students impacted by the transition. When in doubt, issues should be brought to the attention of the NUCLREN Graduate Studies Committee. Although the Nuclear Engineering program is directed primarily toward graduate studies, undergraduate engineers can earn a nuclear engineering minor. In addition, a BS/MS option is available that allows undergraduates to earn up to 12 hours credit of graduate level courses toward both their BS and MS degrees**.** Most nuclear engineering graduate students receive financial support from fellowships, teaching assistantships or research assistantships. A section of the manual is directed to the employment of graduate research and teaching associates. We have recently initiated a non-thesis master's degree option that is primarily oriented toward students whose interests are not primarily related to a research-related career. A brief description of course offerings in Nuclear Engineering is provided online http://mae.osu.edu/courses?subject%5B%5D=NUCLREN. A listing of Nuclear Engineering Faculty with their current areas of interest can be found at http://nuclear.osu.edu/

We encourage both students and faculty to take the opportunity to review this manual. Your comments, suggestions, and recommended changes are welcome and encouraged.

Nuclear Engineering Graduate Studies Committee
2012

INTRODUCTION

Purpose of Handbook

This handbook describes the policies, rules, and procedures of the Nuclear Engineering (NE) Program of The Ohio State University. It is published by the NE Graduate Studies Committee. The Graduate School Handbook (GSH), http://www.gradsch.ohio-state.edu/, provides the rules and policies governing graduate programs as promulgated by the Council on Research and Graduate Studies. The rules and policies of the Nuclear Engineering Graduate Studies Program cannot be less restrictive than those of the Graduate School.

Any waivers or revisions concerning the policies and requirements set forth in this handbook must be approved by the NUCLREN Graduate Studies Committee and in some cases by the University Executive Committee of the Council on Research and Graduate Studies. However, it should be stressed that the NUCLREN graduate program is flexible and can be adapted to the student's needs with the approval of the Graduate Studies Committee.

If you have comments, questions or suggestions concerning these policies and procedures, please feel free to contact your adviser or the Chair of the Nuclear Engineering Program at the following address:

Nuclear Engineering Program
The Ohio State University
E406 Scott Laboratory
Columbus, Ohio 43210-1142 USA
(614)292-8519
E-mail: Nuclear@osu.edu

Find us on the Internet:

Nuclear Engineering:
http://nuclear.osu.edu/

OSU Graduate School:
http://www.gradsch.osu.edu

Educational Philosophy of the Nuclear Engineering Faculty

The Nuclear Engineering Faculty believe that a graduate degree is more than additional course work. It is a time for the graduate student to grow intellectually and personally, learn to work independently, and gain experience in performing research and development. Graduate studies provide the opportunity not only to broaden the individual's knowledge base, but also to obtain a depth of understanding in a chosen field.

Graduate education is a transition period from being a student to that of a professional engineer and researcher. We believe that during your tenure as a graduate student you are a partner in this process, and the Faculty are available to assist in your growth and development as an engineer and as a professional person.

Graduate Student Code of Research and Scholarly Conduct

Graduate students and graduate faculty aspire to professional behavior that is consistent with the highest ethical and moral standards. The Graduate School at The Ohio State University expects that graduate students will demonstrate responsibility and integrity in pursuing their

creative and scholarly interests. The academic enterprise is dependent upon such behavior. Graduate students are responsible for learning about appropriate standards for ethical research and scholarly conduct and for following all university policies related to ethical research and scholarly conduct (GSH Appendix B, I).

Graduate students are expected to be familiar with relevant policies and procedures at Ohio State. Because of recent issues at Ohio State and other universities, students are advised to become familiar with the definition of plagiarism and to assure that material taken from other references is treated appropriately.

2.0 GRADUATE STUDIES ADMISSIONS POLICY

2.1 Admission with Bachelor's Degree

The admission of students to the Graduate School is the dual responsibility of the NUCLREN Graduate Studies Committee and the Graduate School. However, the Graduate School has the final authority for making admission decisions. The Admissions Office receives application material, determines when the application is complete for referral to the Graduate Studies Committee, and notifies the applicant of the admission decision. A submission must satisfy the criteria of Section II.2 and Section II.3 of the GSH. GRE test scores are required of all students that obtained their bachelor's degree from a school other than Ohio State University. Student interested in competing for fellowships are also required to take the GRE.

2.2 Admission Classification

Applicants are admitted to the Graduate School in one of four classifications: regular, special, graduate non-degree, or conditional. See Section II.4 of the GSH.

2.3 Admission with Graduate Credit

Admission requirements are the same as specified under 2.1 above (ref. GSH IV.2). However, previous academic performance at the graduate level will also be considered. A 3.0 cumulative GPA (on a 4.0 scale) is required for work attempted beyond the BS level. Students wishing to transfer graduate credits received from another institution or degree program may petition the GSC for up to six hours of credit, subject to the restrictions of GSH IV.2. The student must have received at least a grade of B for credit to be transferred.

2.4 Admission Credentials and Deadlines

Applicants are encouraged to submit applications for any semester or summer session along with credentials specified in the GSH (ref. II.3 and II.6). The Nuclear Engineering Graduate Program is designed for a student beginning Autumn Semester. However, in almost all cases, a program can be designed for students who wish to initiate their graduate studies during Spring Semester or Summer Session. Applicants who lack one or more of the requirements in

mathematics, physics, or engineering are encouraged to enroll during Summer Session. This will provide an opportunity to remedy course deficiencies prior to beginning the regular course sequences in Nuclear Engineering.

Students wishing to transfer from another academic unit are required to meet the admission requirements in this Handbook and the transfer requirements in the GSH (ref. GSH II.9). If a student is considering a transfer, the student is encouraged to consult with both their current program adviser and the Chair of Nuclear Engineering.

2.5 Re-enrollment

A graduate student who has not been enrolled in the Nuclear Engineering Graduate Program for one or more semesters should contact the Chair of Nuclear Engineering prior to re-enrollment (ref. GSH III.2). The Chair of Nuclear Engineering must obtain approval from the GSC for re-enrollment if:

(1) The period since the last time of registration has been a year or more, or

(2) The student has been placed on probation by the Graduate School.

3.0 REGISTRATION AND SCHEDULING

The registration and scheduling policies of the Nuclear Engineering Program are the same as those of the Graduate School and University. Information on course load requirements and registration/scheduling procedures can be found in Section III.1 of the GSH. Note that fellowship holders must enroll for at least 12 credit hours each semester the appointment is held except in summer session when the minimum is 6 credit hours. Post-candidacy doctoral students must register for a minimum of 3 credit hours.

4.0 COURSE CREDIT, MARKS, AND POINT-HOUR RATIO

The Nuclear Engineering Program policy in these areas is consistent with University and Graduate School standards. Refer to Section IV of the GSH for details.

5.0 ACADEMIC STANDARDS

The student is referred to the GSH, Section V, for a summary of academic standards for remaining in good standing as a graduate student. The Nuclear Engineering GSC expects a student to demonstrate progress toward a degree through enrollment in coursework and involvement in research and development with a potential thesis or task report objective. Progress satisfactory to the Committee can be maintained whether a student is enrolled on a full-time or part-time basis.

6.0 ADVISEMENT AND PROGRAM PLANNING

6.1 Function of Advisers

Upon enrollment each student will be assigned a temporary faculty adviser. A permanent adviser will be designated as soon as possible by mutual agreement between a student and a faculty member. The adviser will assist the student in planning a graduate degree program. The program plan (and subsequent revisions) must be submitted by an adviser to the GSC for approval. The adviser will approve a student's registration in accordance with an approved program. Students are encouraged to register as early as possible each semester to avoid last minute difficulties in obtaining their adviser's approval.

An adviser will approve, supervise, and evaluate individual work performed by a student to fulfill the requirements for a task report, MS thesis, or PhD. dissertation. An adviser will also assist a student in making arrangements for required degree examinations.

If a student desires to change advisers, consultation with the current adviser and the Chair of the Nuclear Engineering Program is required.

It is the joint responsibility of an adviser and a student to complete a degree program in a reasonable period of time.

6.2 Function of the Graduate Studies Committee

An adviser will periodically present to the Graduate Studies Committee (GSC) the academic record
of the student for evaluation of the student's progress. The GSC has the responsibility for approval of all academic aspects of a student's graduate program.

6.3 Student Records

To facilitate academic program planning and respond to future requests for reference by employers, the following informal records are maintained in the Mechanical and Aerospace Engineering Graduate Office:

(1) Transcripts, letters of reference and academic record while attending The Ohio State University Nuclear Engineering Program. In addition, letters and communications pertaining to a student's academic program are kept on file. This typically includes petitions, program plans, notification of change in status, thesis abstracts, etc. A student may inspect his/her folder by obtaining permission from the Chair of Nuclear Engineering. Letters of reference may be removed from the file if the student waived right of access.

(2) Section III.5 of the GSH describes the permanent records maintained by the Office of the Registrar.

6.4 Core Curriculum

All students completing a graduate degree in Nuclear Engineering are required to complete seven core courses with a total of 30 semester credit hours. The core curriculum covers the fundamentals of nuclear engineering and is designed to develop both laboratory and communication abilities. The core consists of NUCLREN 5606, 5742, 6708, 6536, 6725, 6726, and 6766.

Core Course requirements are waived if equivalents have been completed at the undergraduate level. Consult the Nuclear Engineering Program Chair to determine equivalency.

The prerequisites for entry into the core curriculum are:

1) an introductory course in nuclear science and engineering[1],

2) engineering mathematics through differential equations[2],

3) engineering thermodynamics, fluid dynamics, and heat transfer[3].

4) interactive computer-based analyses and design methodology[3].

The core courses are described on the following pages along with the course level, credit hours, and a brief description.

Course Descriptions

NUCLREN 5606: Radiation Protection and Shielding
Course Description: General principles of radiation, radioactivity, and radiation protection including radiation sources, radioactive decay, radiation interactions, radiation detection, radiation shielding, radiation dose calculations, and biological effects.
Student Ranks: Junior, Senior, Masters
Course Offerings: Autumn
Credits: 3.0
Prerequisites and Co-requisites: None

NUCLREN 5742: Nuclear Radiations and Their Measurements
Course Description: Systematic study of nuclear radiation source, interaction with matter and their detection using gas-filled, semiconductor, Scintillation detectors, HPGe spectrometry, pulse processing, and statistical data analysis.
Student Ranks: Masters, Doctoral
Course Offerings: Spring
Credits: 3.0
Prerequisites and Co-requisites: NUCLREN 4505

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[1] A graduate student in Nuclear Engineering may fulfill this prerequisite by auditing NUCLREN 4505 either prior to or concurrently with NUCLREN 6708.
[2] MATH 2415 or equivalent.
[3] A graduate student in Nuclear Engineering may fulfill this prerequisite by completion of a self study program under the guidance of an NUCLREN faculty member.

NUCLREN 6536: Nuclear Reactor Systems and Analysis
Course Description: Intermediate-level course covering thermal and mechanical design aspects of nuclear power plants. The thermodynamics of operating nuclear power plants (BWRs and PWRs) are emphasized.
Student Ranks: Masters, Doctoral
Course Offerings: Spring
Credits: 3.0
Prerequisites and Co-requisites: NUCLREN 4505 and MECHENG 4501 (Thermo)

NUCLREN 6708: Reactor Theory
Course Description: Principles of neutron chain reaction, neutron diffusion and moderation. One, two and multi group diffusion equation and analytical solutions. Heterogeneous reactors and homogenization. Commercial reactors.
Student Ranks: Masters, Doctoral
Course Offerings: Autumn
Credits: 3.0
Prerequisites and Co-requisites:

NUCLREN 6725: Nuclear Reactor Dynamics
Course Description: Nuclear reactor system transient operation, control mechanisms
Student Ranks: Senior, Masters, Doctoral, Professional
Course Offerings: Autumn
Credits: 2.0
Prerequisites and Co-requisites: NUCLREN 6708

NUCLREN 6726: Reactor Dynamics Laboratory
Course Description: Measurement of reactor characteristics and operational parameters using the Ohio State University Research Reactor.
Student Ranks: Senior, Masters, Doctoral, Professional
Course Offerings: Autumn
Credits: 2.0
Prerequisites and Co-requisites: NUCLREN 6708

NUCLREN 6766: Nuclear Engineering Design
Course Description: This course offers a practical experience in the design process within the context of nuclear engineering. Students will be organized into groups. A design project will be specified. Each group will produce and present a final design report.
Student Ranks: Masters
Course Offerings: Spring
Credits: 2.0
Prerequisites and Co-requisites: NUCLREN MS Core

6.5 Seminars

Departmental seminars, featuring guests who speak on topics of interest to nuclear engineers, are offered for the professional benefit of students and faculty. Attendance at a minimum of 75 percent of the seminars presented is required to obtain a "pass" in NUCLREN 6881. (NUCLREN 6881 credit hours are not considered as part of the 30 credit hour MS course requirements.) It is also traditional that faculty attend these seminars. All graduate students

receiving financial assistance and/or enrolled on a full-time basis are required to enroll in NUCLREN 6881.

7.0 MASTER OF SCIENCE PROGRAM

There are two master's degree program plans: Thesis (Plan A) and non-thesis (Plan B). Students may pursue either plan subject to the following procedures of the Nuclear Engineering GSC. The student is encouraged to complete all of his/her work for the MS within a five year time period. Students requiring longer than five years must petition the Nuclear Engineering GSC for approval prior to the end of the five year period.

Graduate Coursework shall include the following components:

(1) Core Curriculum (cf., Section 6.4)

(2) One additional advanced course (5000-level or above) in nuclear engineering

(3) Courses selected for an area of specialization (these courses may also fulfill (2) depending on the area selected--cf., Section 7.6)

(4) MATH 4512 or equivalent must be completed prior to completion of the MS program. This can be a part of the student's BS program or MS program.

7.1 Thesis Option

Under the Thesis Option, an acceptable MS thesis must be submitted based upon individual research supervised by the student's adviser. It is the student's responsibility to develop an acceptable research topic in consultation with his/her adviser. A final oral examination of two hours duration must also be passed. This examination will stress the thesis but may range over the academic work of the student.

In addition, a student must have completed a total of 30 hours of approved graduate course work, with a cumulative point-hour ratio of 3.0 or better. Thesis research may be used to earn credit under NUCLREN 8998, but no more than 6 hours may be included in the overall 30 hours required to complete a graduate program.

Instructions for the preparation and submittal of thesis are provided in the Graduate School Guidelines for Preparing Theses, Dissertations and D.M.A. Documents.

7.2 Non-thesis Option

The non-thesis option is intended for students who do not intend for research to be a major aspect of their career and do not plan to continue to obtain a PhD. Although not precluded, it is expected that these students will not be supported by GRAs, GTAs or fellowships. For students who have completed the undergraduate minor in nuclear engineering, an additional year of course work would be sufficient to fulfill the core course requirements and to broaden their nuclear engineering and mathematics backgrounds beyond the bachelor’s level. Students who

have not taken undergraduate nuclear engineering courses would be eligible for this option but would require more time to complete their degree, in part because of course sequencing issues. In addition to the MS course requirements, the student would undertake a special project under the direction of the student's advisor, leading to the preparation of a project report. The format of the project report may be a comprehensive literature review, a research problem, a data analysis, or other topic acceptable to the GSC. A final presentation is also required followed by oral examination questions on the report content.

7.3 On The Basis of Candidacy Examination

Although GSH Section VI.1 permits the GSC to accept passing of the Candidacy Examination as the basis for awarding a Master's degree, in general the NUCLREN GSC does not accept this alternative. However, a student may petition to the NUCLREN Graduate Studies Committee for this option under special circumstances.

7.4 Planning and Deadlines

The student must comply with deadlines in GSH III.2. Students are encouraged to plan their course programs, and choose the thesis or non-thesis option, as early as possible in consultation with their advisers. Further, each student should plan his/her thesis or task report topic well in advance and obtain advance approval from the GSC on the topic selected.

A complete copy of the approval form for the course schedule must be submitted to a student's adviser no later than the last day of classes for the first semester the student is enrolled in the graduate program. The courses identified shall satisfy the Specialization Area selected (see 7.6).

Students should plan to begin their work on the thesis or task report by the end of their second semester of enrollment.

A student must submit an Application to Graduate form to the Graduate School by the deadline indicated for that semester, in the GSH, Section VI.5. The application is valid for that semester or summer session only.

Submitting this application indicates that the student is expected to complete all degree requirements that semester (ref. GSH VI.4). The form must be signed by the student, the adviser, and the GSC Chair. The degree plan the student is pursuing, the proposed Master's Examination Committee members, and the expected date of the Master's Examination must be listed on the form. The Master's Examination Committee must have a minimum of two members.

Draft copies of theses and task reports are due to advisers at least four weeks before commencement day for the final semester of enrollment before graduation. The thesis must be submitted to the Graduate School by the published deadline for the semester or summer session of graduation. The final thesis must be submitted electronically as a PDF document to OhioLink, the Ohio Library and Information Network.

It is the student's responsibility to initiate these actions and manage the submission schedule.

7.5 Examinations

Students planning to take the Master's Examination must comply with the requirements of GSH VI.6.

7.6 Specialization Areas

Prior to submitting the course approval form, students pursuing a MS degree shall select an Area of Specialization to provide the student depth in a technical area of importance in the nuclear field. Example areas of specialization are listed below. The courses listed are merely recommendations. The program of study is developed by the student in collaboration with his/her advisor and approved by the GSC.

Nuclear Fuel Cycle and Waste

This area of specialization is broad in nature, covering most of the nuclear fuel cycle, and is recommended for students interested in all aspects of nuclear energy. This specialization provides a variety of alternatives for graduates entering the job market, preparing them to obtain employment in almost any area of nuclear energy, including uranium mining, milling, enrichment, nuclear fuel fabrication, in-core fuel management, fuel reprocessing, and nuclear waste management. Preparation in engineering or physics is desirable. This area is appropriate for students with chemical engineering, mechanical engineering, engineering physics and environmental sciences backgrounds. Suggested electives: NUCLREN 5776 and 5716.

Nuclear Instrumentation and Control

Nuclear power plant I&C design requires knowledge of what is measured, how to measure it, how the measured information is used and what is being controlled. This specialization is thus inherently basic. The completion of this specialization will naturally lead to dual M.Sc. degrees with mechanical engineering, electrical engineering or computer engineering. Preparation in nuclear, mechanical or electrical engineering is recommended for the specialization program in Nuclear Power Plant I&C. Suggested electives: NUCLREN 5716 and 6777.

Nuclear Medical Instrumentation

Nuclear Medicine is a major discipline that utilizes radioisotopes for the diagnosis of disease. The design and operation of instrumentation required to measure and display diagnostic information from radioisotopic medical studies represents a challenging engineering task. Currently there are a number of corporations supplying instrumentation for medicine. The specialization program in nuclear medical instrumentation will prepare a student for employment in such a corporation or for work in hospitals using radioisotopic procedures.

Recommended preparation for the nuclear medicine instrumentation specialization includes course work in physics, engineering physics, chemistry or electrical engineering, and preferably one or two courses in the biological sciences with an emphasis on laboratory and experimental work.

Nuclear Power Plant Engineering and Operations

The need for power plant engineers and engineering personnel on site at nuclear power plants for safe and economic operation during each shift became evident following the Three Mile Island accident. The Nuclear Regulatory Commission now requires personnel with engineering degrees to be an integral part of plant operation in a nuclear utility. This program provides an internship in operations with a nuclear power plant if desired. The nuclear engineering faculty will assist a student in making arrangements for internship employment.

Preparation in nuclear, mechanical, or chemical engineering is recommended for the specialization program in nuclear power plant engineering and operations. Suggested electives: NUCLREN 5716, 5735, and 5610.

Nuclear Reactor Core Design Computational Methods

The design of the reactor core requires an understanding of basic nuclear engineering, plus the interactions of core thermal hydraulics and structural support materials. The challenge to the core designer is to provide for the most efficient use of our nation's uranium resources, while still ensuring the health and safety of the work force and the general public. This specialization program will prepare the student for research in reactor fuel utilization and core design as well as for employment with the in-core fuel management sections of utilities, reactor manufacturers, or any of the nuclear consultant companies.

Preparation in nuclear or mechanical engineering or physics is recommended. Suggested Electives: NUCLREN 6707 and 7865.

Radiation Protection and Measurement

An understanding of the impact of radiation on humans and their protection from radiation is a significant aspect of the safe and economic operation of nuclear power plants and the application of radioisotopes to medicine and industry. The radiation protection specialization prepares the student for design, analysis, and implementation of radiation protection programs.

Preparation in nuclear engineering, physics or chemistry with course work in the biological sciences is recommended. Suggested electives: NUCLREN 5776.

Risk and Reliability

Probabilistic risk assessment (PRA) has recently become a regulatory requirement in the licensing of nuclear power plants. The PRA considers both the magnitude and the frequency of events in the quantification of their possible impacts. In this respect, the PRA uses both statistical and deterministic techniques. This specialization program prepares the student for regulatory and research careers in PRA, as well as employment with the utilities as a maintenance or reliability engineer.

Preparation in nuclear, mechanical, electrical engineering or statistics is recommended. Suggested electives: MECHENG 5665, and 5666, and NUCLREN 5610, 5716, and 5717.

Safety Analysis

In the design and licensing of new nuclear power plants, there will be a high demand for students with experience in safety and risk analysis. The focus of this area of specialization is our reactor safety concepts, operational safety, and risk-informed regulation. .Preparation in

nuclear, mechanical or electrical engineering is recommended. Suggested electives: NUCLREN 5610, 5716, 5717, and 5735.

Thermal Hydraulics

An understanding of the fundamental principles of thermal science (thermodynamics, fluid dynamics, and heat transfer), and an ability to apply those principles in practice is important to the overall design of nuclear power plants, especially the balance of plant. In addition, analysis of various potential reactor accident scenarios requires a working knowledge of the principles of thermal science. This specialization will prepare the student for employment in both industrial and governmental agencies and laboratories involved in reactor design and analysis.

Preparation in mechanical, nuclear, or chemical engineering is recommended for an specialization in Thermal Science. Suggested electives: NUCLREN 6537 and 7538.

8.0 COMBINED GRADUATE DEGREE PROGRAMS

8.1 BS/MS Graduate Degree Program

The combined BS/MS Degree program in Nuclear Engineering is an opportunity available for qualified undergraduates in Engineering or Engineering Physics. Excellent students are able to initiate the Master's Program (research) during the Senior year, with the possibility of completing their MS within two semesters following completion of the Bachelor's requirements. Graduate Research Associate (GRA) appointments may be available following admission to the BS/MS Program by the Graduate School. A GRA appointment includes a monthly stipend plus a tuition waiver. Before graduation, appointments will be 25%; upon graduation, with a BS, appointments will become 50%.

Admissions Requirements

- Senior Level standing in Engineering or Engineering Physics
- Completion of 90 undergraduate credit hours
- Minimum 3.5 Cumulative GPA in all previous undergraduate work
- Completion of NUCLREN 4505
- Completion of basic course work in Thermodynamics, Fluid Flow, Heat Transfer (i.e., MECHENG 3501, 3503, 4510; or MECHENG 3500; or CHBE 3508, 3521)
- Completion of Mathematics through differential equations (MATH 2415 preferred)
- Application for admission to the Nuclear Engineering program following normal process with indication of intent to enter combined BS/MS program
- Admission by the Nuclear Engineering Graduate Studies Committee and the Graduate School

Additional Requirements to Complete Program

- BS requirements as specified by the program in which the student is enrolled.

- MS in Nuclear Engineering requirements as specified by the Graduate School and Section 9 of this handbook.

- Suggested Courses Available for Dual BS/MS Credit: (12 hours maximum) any 5000 or 6000 level NUCLREN course

A form is used to track progress through the combined BS/MS program. During the semester before you enroll in the program and the semester you graduate with the BS and MS degrees, the form must be submitted to the College of Engineering.

8.2 Dual Masters Degree Program

Subject to the conditions in GSH Section VI.7 and VI.8, the NUCLREN Program does allow dual master's degrees.

8.3 Undergraduate Minor in Nuclear Engineering

The nuclear industry expanded rapidly in the 1960s and early 1970s and during that time hired thousands of engineers and scientists. Now those people are approaching retirement age, and the nuclear industry needs to replace them. Electric utilities, national laboratories, and government regulatory agencies need both nuclear engineers and scientists and engineers in other fields who also have some knowledge of nuclear technology. Because so many senior people are retiring, there will be many opportunities for rapid advancement in the nuclear industry over the next several years. Ohio State now offers an undergraduate minor in Nuclear Engineering to provide students with the knowledge and skills they will need for many entry level positions in the nuclear industry.

The undergraduate minor in Nuclear Engineering requires 2 core courses and 2 additional courses selected from a list of specializations. Different major programs allow different numbers of courses taken for the minor to be counted as satisfying technical elective requirements. The courses offered in the Nuclear Engineering minor are:

Core

NUCLREN 4505 Nuclear Science and Engineering (3 credit hours) – AU and SP
NUCLREN 4536 Nuclear Reactor Systems (3 credit hours) - SP

Options (select a minimum of 6 credit hours from the following courses)

NUCLREN 4506 Undergraduate Nuclear Engineering Laboratory (3 credit hours)- AU
NUCLREN 4701 Reactor Physics (3 credit hours)- AU
NUCLREN 5606 Radiation Protection and Shielding (3 credit hours)- AU and SP
NUCLREN 5610 Reactor Safety (3 credit hours)- SP
NUCLREN 5716 Probabilistic Risk Assessment (3 credit hours)- AU

NUCLREN 5717 Human Reliability Analysis (3 credit hours)- SP
NUCLREN 5776 Radioactive Waste Management/Nuclear Fuel Cycles (3 credit hours)- AU
NUCLREN 5742 Nuclear Radiations and Their Measurements (3 credit hours)- SP
NUCLREN 5735 Nuclear Power Plant Operations (3 credit hours)- SP
NUCLREN 6537 Nuclear Reactor Thermal Hydraulics* (3 credit hours)- AU
NUCLREN 6708 Reactor Theory* (3 credit hours)- AU
NUCLREN 6725 Reactor Dynamics* (2 credit hours)- AU
NUCLREN 6726 Reactor Dynamics Laboratory* (2 credit hours)- SP

*With permission of instructor. If NUCLREN 6725 and 6726 are selected and approved, the student needs to take a total of five courses to satisfy the minimum requirement of 12 cr. hr.

If you are interested in pursuing the undergraduate minor in Nuclear Engineering, simply complete the Minor Program Form which is available in the College Office (Room 122 Hitchcock Hall) or online at http://mae.osu.edu/undergraduate/minors/ne-minor. List the Nuclear Engineering courses you plan to take and the semester and year in which you plan to take them. The Minor Program Form is not binding and does not commit you to taking the courses in the semester you indicate. It simply informs us that you plan to participate in the Nuclear Engineering Minor program and helps us to plan our teaching loads.

9.0 DOCTOR OF PHILOSOPHY PROGRAM

9.1 Admission to Candidacy

In the path toward obtaining a Doctor of Philosophy in the Nuclear Engineering program a student passes through three stages: PhD track, PhD Qualified, and PhD Candidate. When a student with a bachelor's degree or a master's degree applies to the Graduate School, that student can be accepted on a PhD track or on an MS track. Typically, students are accepted on an MS track, but, if their academic record warrants, they can be accepted on a PhD track. A student on a PhD track can choose to obtain an MS degree on the way toward the PhD degree. When an MS candidate takes the Master's Examination, the Examination Committee recommends whether that student should be permitted to continue on a PhD track.

After completing the majority of his/her course work, NUCLREN students must take the Preliminary or Qualifying Examinations, as discussed in GSH VII.3. These Qualifying Examinations are under the jurisdiction of the NEGSC. They are described in Section 9.2. A student that has passed his/her Qualification Examinations is qualified to continue as a doctoral student and later to take the Candidacy Examinations.

The Candidacy Examination is taken after the student's course work has been completed and the scope of dissertation has been defined. The examination must be completed no later than two semesters or one semester and a summer session before graduation. The Candidacy Examination is described in GSH VII.4

9.2 Course Requirements

The course requirements for the Doctor of Philosophy degree are incremental to the requirements for the M.S. degree. In addition to satisfying the M.S. requirements, the following additional requirements must be satisfied. The student must complete two additional

mathematics courses at the 5000 level (a statistics course can be substituted for a mathematics course); NUCLREN 6537 (Nuclear Reactor Thermal Hydraulics); NUCLREN 7865 (Neutron Slowing Down Theory); and at least two additional advanced nuclear engineering course at the 5000 level or higher.

To the extent that required or comparable courses have been taken by the student prior to entering the PhD program, either at OSU or another institution, the student can petition the Graduate Studies Committee to substitute other courses

9.3 PhD Qualifying Examination

The qualifying examination covers the essential principles of nuclear engineering under the following three general topics and one of the special topics: (Specific recommended course preparation indicated in parentheses.)

General Topics

- Reactor Physics and Engineering
  (NUCLREN 4505, 5708, 5725 and 5726)
- Radiation Physics (Radiation Protection/Health Physics), and Interaction with Matter (Detection, Instrumentation, Shielding)
  (NUCLREN 5606, 5742, and 5766)
- Thermodynamics, Fluid Flow and Heat Transfer
  (MECHENG 4501; NUCLREN 7536 and 6766)

Speciality Topics

- Advanced Reactor Physics, Kinetics and Dynamics
  (NUCLREN 5708, 5725 and 5726)
- Fuel Cycle and Waste Management
  (NUCLREN 5766)
- Health Physics, Radiation Protection and Shielding
  (NUCLREN 5606 and 5742)
- Advanced Thermal Hydraulics
  (NUCLREN 6536 and 6537; MECHENG 6505 and 6510)
- Advanced Reactor Instrumentation and Control
  (NUCLREN 6725, 6726 and 5742; MECHENG 3870)
- Advanced Topics in Safety and Risk Assessment
  (NUCLREN 5610, 5716 and 5717)

The examination is prepared and graded by the Graduate Studies Committee and is offered as needed. Dates for the Examination will be announced.

It is recommended that a student take the Qualifying Examination before completing 50 hours of letter graded graduate credit in the program.

A student wishing to take the qualifying examination should obtain the approval of his/her adviser, and submit a request in writing to the Chair of the Nuclear Engineering Program during the first week of the semester in which the examination is offered. Students may obtain copies of previous examinations from the Nuclear Engineering Program office.

A student may use the qualifying examination as the Master's Examination for the MS non-thesis option if he/she so chooses. However, the examination will still be considered an attempt to pass the PhD. qualifying examination. Students planning to use this option for the MS degree must file an Application to Graduate with the Graduate School for that semester.

The PhD. Qualifying Examination may only be taken twice. A passing score in each section is required to pass the PhD. Qualifying Examination. A student with one (1), or two (2), sections with unsatisfactory grades must, at the next offering, retake only those parts of the examination on which an unsatisfactory grade was received. A student with three (3) or four (4) sections with unsatisfactory grades must retake the entire examination at the next offering.

The PhD. qualifying examination may be waived upon petition for students with accumulated GPA of 3.9 or above and 18 credit hours of graded nuclear engineering courses (with a minimum 10 credit hours from the NUCLREN Core Curriculum as described in section 6.4). If the student has received an M.S. degree in nuclear engineering from a university other than The Ohio State University, the student may request up to 10 credit hours of the courses taken at the other institution that correspond to the courses listed in the NUCLREN Core Curriculum as described in section 6.4 to be counted towards the 18 credit requirement. If the request is approved by the NUCLREN Graduate Studies Committee, then the student needs to maintain a minimum GPA of 3.9 for the 6000-level or above nuclear engineering courses taken at The Ohio State University to fulfill the 18 credit requirement.

Complete Math 4512 or equivalent, two additional mathematics courses at the 5000 level (one statistics course can be substituted for one mathematics course).

9.4 Candidacy Examination

The Candidacy Examination is described in GSH VII.4, VII.5, VII.6, and VII.7. The student's advisor will chair the Examination Committee. Composition of the Candidacy Examination Committee is described in GSH VII.4.

9.5 Dissertation Proposal

Requirements for the Doctoral Dissertation and the membership of the Dissertation Committee are described in GSH VII.9.

The student must prepare a PhD. Dissertation Proposal which shows that completion of the proposal research will be a contribution and that the research can be completed in a reasonable time using facilities, capabilities and equipment either readily available or easily attained.

The student, in consultation with the adviser, formulates a concise, typed Dissertation Proposal which should include the following:

Title and abstract
Planned specialty areas
Significance of the problem and literature review
Scope and objectives
Methodology and time line
Expected results and conclusions
Expected contributions to the state of the art/literature

The Dissertation Proposal is submitted to the members of the Advisory Committee for evaluation. The student then makes an informal oral presentation of the proposal to the committee and answers questions. This presentation allows the committee to reach a consensus on the suitability of the proposed topic for a PhD. dissertation. The committee may

request revisions in the proposal. When the Advisory Committee is satisfied with the suitability of the topic and proposed plan of research, the proposal is signed and then submitted to the Graduate Studies Committee for final approval.

9.6 Final Oral Examination

After the Dissertation Committee has given preliminary approval of the dissertation, a final oral examination will be given as prescribed in GSH VII.10.

9.7 Graduation Requirements

Graduation requirements are summarized in GSH VII.13 and VII.14.

10.0 FINANCIAL ASSISTANCE

10.1 Appointment and General Requirements

A student admitted to the graduate program with financial assistance in the form of a Graduate Associate's appointment is provided a 50% time Graduate Associateship for Autumn and Spring semester (ref. GSH IX.2). Renewal and salary adjustments for Graduate Associateships will be based on the following criteria:

(1) Satisfaction of the eligibility requirements in GSH IX.1

(2) Satisfactory academic performance (3.0 GPA). The graduate associateship will be terminated if a student is on academic probation for two semesters.

(3) Satisfactory work performance as assessed by a student's supervisor in consultation with the student's academic adviser (usually the same).

(4) Availability of funds.

If the student's performance is satisfactory and research funding is for some reason terminated, every effort will be made by a student's adviser and the Chair of the Nuclear Engineering Program to obtain a new project assignment. This is rarely a difficulty if a student's work performance has been of high professional quality.

The total number of semesters that an MS student may receive financial aid of any type shall normally not exceed eight (8) semesters. This limit may be extended through the submission of a petition to the Graduate Studies Committee.

Appointments at the 25% and 75% level are possible under special circumstances within the restrictions of GSH IX.2.

10.2 Stipends and Benefits

New GAs usually receive equal stipends. GA stipends are adjusted (as funding allows) following a review of both academic and work performance, including progress toward completion of degree requirements.

GAs receive the following benefits:

1) Stipend

2) Fee Authorizations as described in GSH IX.5

3) An office with 24-hour accessibility

4) A shared mail box

5) Option of purchasing a staff parking sticker

6) Special library privileges

7) Subsidy of health insurance as stipulated in GSH IX.5

10.3 Work Expectations

A student may be employed as a Graduate Research or Teaching Associate for 50% time, requiring 20 hours of work per week. The weekly workload is flexible, depending on the nature of a job and the student's academic requirements (i.e. exams, etc.). However, over any given semester, a student is expected to devote an average of 20 hours per week to a job assignment.

Circumstances permitting a student to increase work time (to a maximum of 75%), with a proportional increase in salary, include the following:

(1) Unusual demands of a job that can only be fulfilled by a particular student. This is usually temporary.

(2) Assignment to two or more research projects.

(3) Supervisory or project management responsibility.

In all cases, increased time requirements must be agreed to and approved by the student, his/her adviser, and the Chair of the Nuclear Engineering Program. The policy of increased time also applies to employment of Nuclear Graduate Students by other units of the University.

10.4 Guidelines for Between Semester Breaks

GA appointments include between-semester breaks. The following guidelines regarding semester break periods are recommended:

(1) Do slow down - we all need a break from the 60-80 hour weekly grind.

(2) Arrange a vacation period with your project supervisor. This should not exceed 10-20% of the total working days during the break. This should permit a one week vacation period during the December academic break.

(3) Arrange to make up this vacation time to avoid falling behind in your job assignment.

(4) Semester break is an excellent time to complete tasks requiring extensive periods without distractions or the use of equipment shared with teaching labs.

(5) GTAs usually are not required to be on duty between semesters. However, they are expected to prepare for their next semester assignments and may be asked to assist in other related tasks such as preparation of experiments.

10.5 Grievance Procedure

A GA employed by the Nuclear Engineering Program has the same professional responsibility to the project or classroom assignment as would be expected by any employer in the private or public sector. Conversely, the GA has the right to be treated as a professional by his/her supervisor (GSH Appendix D).

10.6 Fellowships

The terms and conditions of OSU Graduate School Fellowships are defined in GSH X.1. The terms and conditions of other fellowships can vary widely depending on conditions imposed by the funding organization and agreements developed among the funding organization, the recipient, and OSU.