

University of Idaho

**GRADUATE STUDENT HANDBOOK**  
NUCLEAR ENGINEERING PROGRAM

College of | **Engineering**

4<sup>rd</sup> Edition  
June 2013

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## PREFACE

This handbook describes the policies and procedures of the Nuclear Engineering Program at The University of Idaho and supplements the information in the current University of Idaho General Catalog. It includes discussions of academic and examination requirements for both MS and PhD programs. An undergraduate nuclear engineering program is not offered at this time. The MS and PhD program requirements are, at a minimum, consistent with those of the College of Graduate Studies. A summary of the University requirements for graduate degrees can be found at the [Registrar's Office](#) under the [catalog link](#). Competitive research and teaching assistantships may be available. Early application to the degree program is encouraged. A listing of Nuclear Engineering Faculty with their current areas of interest can be found in Appendix A. Information in this handbook is offered as a guide for advising and is subject to change without notice. The General Catalog and university policies and regulations supercede materials in this handbook.

Nuclear Engineering Graduate Studies Committee  
June 2013

## 1.0 Introduction

### 1.1 *Purpose of Handbook*

This handbook describes the policies, rules, and procedures of the Nuclear Engineering (NE) Program of The University of Idaho. The [College of Graduate Studies](#) website provides the rules and policies governing graduate programs and offers a multitude of resources designed to encourage a successful graduate experience.

Any waivers or revisions concerning the policies and requirements set forth in this handbook must be approved by the NE Graduate Program Committee and in some cases the College of Graduate Studies. However, it should be stressed that the NE graduate program is flexible and can be adapted to the student's needs when appropriate.

If you have questions concerning the policies and procedures outlined in this handbook please contact the Director or Academic Program Coordinator.

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#### **Admissions:**

[www.uidaho.edu/graduateadmissions](http://www.uidaho.edu/graduateadmissions)  
[www.uidaho.edu/cogs](http://www.uidaho.edu/cogs)

<http://www.uidaho.edu/idahofalls/nuclearengineering>

### 1.2 *Educational Philosophy of the Nuclear Engineering Faculty*

The Nuclear Engineering Faculty believe that a graduate degree is more than additional course work. Adjusting from undergraduate to graduate work involves a transition in the way you approach your studies. Graduate education is a transition period from being a student to that of a professional engineer and researcher. It is a time for the graduate student to grow intellectually and personally, create new knowledge, learn to work independently, and gain experience in performing research and development. Graduate studies provide the opportunity to broaden the individual's knowledge base, to obtain a depth of understanding in a chosen field and to prepare oneself for an increasingly competitive job market. The faculty value your success and are available to assist in your growth and development as an engineer and as a professional person.

The Nuclear Engineering faculty at the University of Idaho believes that it is a privilege to work and study in collaboration with leaders in the field of nuclear engineering and recruit only the brightest and most capable students. The UI Nuclear Engineering program's ideal location to, and partnership with, the Idaho National Laboratory creates opportunities for students to interact with the researchers at the lead nuclear research facility in the U.S. Students can work and study at the Center for Advanced Energy Studies, a research facility that is operated collaboratively with the INL. We believe that students are an important part of this collaboration and in support of that; every effort is made to a foster world-class research and education environment.

### *1.3 Graduate Student Code of Research and Scholarly Conduct*

The University of Idaho expects that students will engage in academic activity with high standards of honesty and integrity. The academic enterprise is dependent upon such behavior. These values are central to the educational process and are also cornerstone values for citizenship and professional conduct after you leave the University. 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.

The University of Idaho has specific academic honesty expectations described in the [Student Code of Conduct](#). These are minimum standards that are generally applied across the University. However, professors may more specifically define standards for their courses through information described in the course syllabus or other documents. You must learn the expectations of each instructor since learning environments do vary both in content and teaching style. Sometimes the issues of academic integrity are obvious but other times you may struggle with issues that appear to be less clear. Talk with your instructor if you have a concern about what is expected of you.

### *1.4 Nuclear Engineering Program Learning Outcomes*

In alignment with the University of Idaho [Learning Outcomes](#), the faculty of the Nuclear Engineering Program have developed outcomes for the masters and doctoral students. Learning outcomes both direct and assess programs and allow for continuous improvement. As such, the outcomes and assessments at each level can change from year to year in order to maintain a high standard of teaching and learning.

The outcomes for the masters and doctoral students are listed in Appendix C.

## **2.0 GRADUATE STUDIES ADMISSION POLICY**

Admission to the [College of Graduate Studies](#) (CoGS) is open to any student who holds a baccalaureate degree and who presents a scholastic record indicating probable success in graduate work. The [General Catalog](#) lists the University's GPA admission requirements.

### **3.0 ADMISSION TO THE NUCLEAR ENGINEERING GRADUATE PROGRAM**

#### *3.1 Admission with Nuclear or Mechanical Engineering Undergraduate Degree*

Admission to the [Nuclear Engineering Graduate Program](#) is open to any student who is admissible to CoGS if his or her baccalaureate degree is in mechanical or nuclear engineering from an A.B.E.T. accredited U.S. program. Admission is subject to enrollment limits.

#### *3.2 Admission with Undergraduate Degree in Non-Nuclear/Mechanical Engineering Field*

Students with a baccalaureate degree from an accredited U.S. engineering program with a major other than nuclear or mechanical engineering may also be admitted to the Nuclear Engineering Graduate Program, subject to enrollment limits. However, such students must demonstrate a basic proficiency in the areas of chemistry, mathematics, physics and energy. This may require the student to include courses, in addition to the 30 credits of graduate courses required for the Master's degree. These are assigned as a part of the student's study plan as undergraduate deficiencies. The subjects included in the following list define the areas for which proficiency is expected as an entrance requirement.

**Energy:**

Thermodynamics (Engr 320)

Fluid Dynamics (Engr 335)

Heat Transfer (ME 345)

**Chemistry and Physics:**

Principles of Chemistry II (Chem 112)

Modern Physics (PHYS 305)

**Mathematics:**

Numerical Methods

Computer Programming Language(s)

Each applicant to the program is evaluated individually. Exceptions and/or substitutions may be made to the above requirements.

#### *3.3 Admission with a Non-Engineering Undergraduate Degree*

Students who do not have a U.S. engineering baccalaureate degree may also be admitted to the Nuclear Engineering Graduate Program. However, such students must demonstrate a proficiency in the basic subjects included in an undergraduate engineering program. This may require the student to include courses, in addition to the 30 credits of graduate courses required for the Master's degree, which are assigned as a part of the student's study plan as undergraduate deficiencies. The subjects included in the following list define the areas for which proficiency is expected as an entrance requirement.

1. An appropriate combination of mathematics and basic science including:
  - Multivariable Calculus (Math 275)
  - Ordinary Differential Equations (Math 310)
  - Probability and Statistics (Stat 301)
  - Chemistry (Chem 111 & 112)
  - Calculus based physics (Phys 211, 212, 213).
2. Sixteen credits of humanities and social sciences including both breadth and depth.
3. Forty-eight credits of engineering topics which include engineering science and engineering design.
  - Engineering science will include:**
    - Mechanics (Engr 210, Engr 220, Engr 350)
    - Thermodynamics (Engr 320)
    - Electrical Circuits (Engr 240)
    - Materials Science (MSE 201)
    - Transport Phenomena (Engr 335, ME 345)
  - Engineering design must include:**
    - ✓ A meaningful, major engineering design experience that was built upon the fundamental concepts of mathematics
    - ✓ Basic science, humanities and social science, engineering topics and communication skills
    - ✓ A capstone design experience such as ME 424/426 is required
4. Appropriate laboratory experience such that the student is competent to conduct experimental work (laboratory classes are required which include an instrumentation class such as ME 330).
5. Appropriate computer-based experience including the computational techniques needed to solve specific engineering problems (classes such as ME 123/223 are required along with other classes where computers were used to solve specific engineering problems).
6. Competence in written and oral English communication, including both English composition (e.g. - Eng 102) and English technical writing (e.g. - Eng 317).
7. An understanding of the ethical, social, economic, and safety considerations in engineering practice (see engineering design under item 3 above).

The evaluation of equivalent classes will be done on an individual basis. If a student does not have the equivalent of one of the above classes (except capstone design), the student may take the class or challenge it (see procedures for challenge process in [General Catalog](#)) after appropriate self-study.

### 3.4 *International Student Admissions*

International students without a U.S. baccalaureate degree must meet university requirements for admission, as well as program requirements listed above.

### 3.5 *Graduate Record Examination and GPA*

Graduate Record Examination (GRE) test results are recommended but not required for applicants with an engineering baccalaureate degree from a U.S. ABET accredited program. For all other applicants, GRE general test results are required. These GRE scores and the applicant's grade point average (GPA) aid the faculty in estimating the applicant's scholastic abilities, which are suggestive of probable success in graduate work and are helpful in counseling students in their courses of graduate study. The GRE areas of interest and expected minimum scores are as follows:

For an explanation of the scores please visit [www.gre.org](http://www.gre.org).

### 3.6 *Proof of English Competency (TOEFL)*

For [Graduate Admission](#) purposes, all students must meet Academic and Language Requirements. A waiver for this requirement is automatically granted to applicants whose education is from countries where English is the official/native language. The most common and widely accepted test is the TOEFL ([Test of English as a Foreign Language](#)).

The TOEFL iBT test measures your ability to use and understand English at the university level. And it evaluates how well you combine your listening, reading, speaking and writing skills to perform academic tasks. For more info about test content please visit [www.ets.org/toefl](http://www.ets.org/toefl).

The institution code for the TOEFL is 4843.

#### Minimum Required Test Scores

Internet Based: 83

Paper Based: 560

\*All tests must have been taken within 2 years of the semester you are applying.

## 4.0 M.ENGR. DEGREE REQUIREMENTS & PROCEDURES (NON-THESIS)

Thirty credits are required for the M.Engr. (non-thesis) degree in Nuclear Engineering.

- At least 18 credits must be at the 500 level.
- No credits may be at the 300 level or lower.
- No classes required for the undergraduate degree can be used as part of the graduate program.

The University of Idaho - Idaho Falls maintains a [Three Year Plan](#) for the rotation of courses. University of Idaho reserves the right to change the Three Year Plan at any time due to enrollment requirements or other course scheduling issues.

The combined total of transfer credits, correspondence credits, non-matriculated credits, and approved credits more than eight years old at the time the degree is awarded shall not exceed 12 credits for master's programs. It is advisable for students to apply for admission prior to, or early in, their coursework.

Credits earned at an institution that does not grant graduate degrees cannot be transferred to University of Idaho for graduate credit. For questions about the transferability of a course, contact the NE Director, Program Coordinator or [COGs](#).

All other credits submitted to meet the requirements for a Master's degree must have been earned within the eight consecutive years that immediately precede the academic session in which the degree is completed.

### 4.1 Program

Students interested in the program should contact the program director well in advance of the first registration for a tentative evaluation of educational preparation. Deficiencies in undergraduate course preparation for the graduate program will be identified.

### 4.2 Nomination of Major Professor

The student, program director, and potential major professor should discuss and formalize the nomination of the major professor **before the student has completed three classes**. The nominated major professor, in conjunction with the student must submit the [Appointment of Major Professor and/or Committee Form](#) to the [College of Graduate Studies](#).

### 4.3 Committee

A supervisory committee is not required for the M.Engr. non-thesis degree.

#### 4.4 Study Plan

Your Study Plan should be prepared **by the time three classes are completed**. The major professor, department and graduate Dean approve the study plan submitted by the student through the university's VandalWeb. The major professor must be listed on VandalWeb, before the plan can be approved. Students are encouraged to create a draft prior to this.

#### 4.5 Capstone Requirement

Students should meet with their major professor to discuss options for the capstone. A comprehensive exam, paper submitted for publication, and other scholarly activities may be considered for this requirement. After the capstone is completed, the [Non-Thesis Requirement Report](#) must be completed by the major professor and submitted to the College of Graduate Studies.

#### 4.6 Application for Advanced Degree

Form is completed on-line through [VandalWeb](#) before the end of the semester prior to the semester in which the student intends to graduate.

#### 4.7 Information

Further information on university and general regulations may be obtained from the University of Idaho [College Of Graduate Studies](#) and the [Office of the Registrar](#).

### 5.0 M.S. DEGREE REQUIREMENTS & PROCEDURES (THESIS)

Thirty credits are required for the M.S. (thesis) degree in Nuclear Engineering.

- At least 18 credits must be at the 500 level.
- No credits may be at the 300 level or lower.
- No classes required for the undergraduate degree can be used as part of the graduate program.

The University of Idaho - Idaho Falls maintains a [Three Year Plan](#) for the rotation of courses. University of Idaho reserves the right to change the Three Year Plan at any time due to enrollment requirements or other course scheduling issues.

The combined total of transfer credits, correspondence credits, non-matriculated credits, and approved credits more than eight years old at the time the degree is awarded shall not exceed

12 credits for master's programs. It is advisable for students to apply for admission prior to, or early in, their coursework.

Credits earned at an institution that does not grant graduate degrees cannot be transferred to University of Idaho for graduate credit. For questions about the transferability of a course, contact the NE Director, Program Coordinator or [COGs](#).

All other credits submitted to meet the requirements for a Master's degree must have been earned within the eight consecutive years that immediately precede the academic session in which the degree is completed.

### *5.1 Program*

Students interested in the program should contact the program director well in advance of the first registration for a tentative evaluation of educational preparation. Deficiencies in undergraduate course preparation for the graduate program will be identified. Students should review Appendix A and contact faculty with mutual research interests as well as the Program Director.

### *5.2 Nomination of Major Professor*

The student, program director, and potential major professor should discuss and formalize the nomination of the major professor **before the student has completed three classes**. The nominated major professor in conjunction with the student must submit the [Appointment of Major Professor and/or Committee Form](#) to the [College of Graduate Studies](#).

### *5.3 Committee*

The Committee will be discussed by the student and the major professor in consultation with the Program Director. Your committee must include:

- ✓ Major Professor (Chair)
- ✓ One member from the Nuclear Engineering Program (Inside Member)
- ✓ One member from another department (Outside Member)

The Chair must be UI Graduate Faculty, the Inside Member may be UI Faculty or an eligible Adjunct Faculty member. Additional members may be appointed if desired. An outside member from another institution may be approved if graduate faculty at that institution and if the department determines that he or she is appropriate for the student's committee. At least fifty percent (50%) of the committee members must be members of the graduate faculty.

## 5.4 Study Plan

Your Study Plan should be prepared **by the time three classes are completed**. The major professor, department and graduate Dean approve the study plan submitted by the student through [VandalWeb](#). The major professor must be listed on VandalWeb, before the plan can be approved. Students are encouraged to create a draft prior to this. Faculty members on the committee are expected to have input on the study plan development.

## 5.5 Request to Proceed to Final Defense

After detailed consultations with the major professor, the student provides each committee member with a copy of the thesis that will be defended. It is recommended that the committee be given 3-4 weeks to review the study.

Students must schedule the defense meeting with the committee members and then collect each member's signature on the Request to Proceed with Final Defense Form. The student must submit the signed form to the College of Graduate Studies prior to the defense meeting. It is recommended that the form be in the Dean's Office at least a week prior to the defense date. A copy of the title page of the thesis must be attached to the Report of Final Defense form, and the completed thesis submitted within 6 months. The entire committee must participate in the thesis defense.

## 5.6 Thesis Defense

The defense consists of 20-30 minutes of presentation with professional scholarly slides. After the candidate's presentation, the major professor will facilitate questioning of the candidate by the committee. The committee will then deliberate in a private session to determine the outcome of the defense. Upon completion of the deliberation, the candidate will meet with their committee in a private session to learn the committee's decisions on further research or edits needed. If the defense is not acceptable to the majority of the committee, a new defense must be scheduled after the changes are made. Thesis defenses are open to the public.

It is imperative that students follow the guidelines and instructions set forth for Thesis Defense. Please review the following prior to beginning the thesis to ensure compliance with all requirements.

- ✓ [Deadlines to submit Thesis, Dissertations and Non-Thesis Report Forms](#)
- ✓ [Tips for Starting \(And Finishing!\) Your Thesis or Dissertation](#)
- ✓ [Master's Thesis Proposal Instructions](#)
- ✓ [Handbook for Writing Thesis & Dissertations](#)

Further information on university and general regulations, including required forms and Graduate Handbook for Theses and Dissertations, is available from the University of Idaho, [College of Graduate Studies](#) and the [Registrar](#).

Thesis defenses are open to the public including other faculty and students.

### *5.7 Submission of Final Thesis*

Complete instructions for formatting and submission are found in the [Graduate Handbook for Theses and Dissertations](#). It is important to follow the instructions to the letter.

Further information on university and general regulations may be found, including the Graduate Handbook for Theses and Dissertations and forms, from the University of Idaho [College Of Graduate Studies](#) or the [Registrar](#).

## 6.0 NUCLEAR ENGINEERING MASTERS DEGREE COURSE PLAN – 30 CREDITS

Prerequisites may need to be taken prior to enrolling in these courses. Check [www.uidaho.edu/registrar](http://www.uidaho.edu/registrar), catalogs.

| *Courses                              | Bachelor's Degree in Nuclear Engineering  | Bachelor's Degree in Physics or Chemistry | Bachelor's Degree in Mechanical Engineering | Bachelor's Degree in Chemical Engineering |
|---------------------------------------|---|---|---|---|
| <b>CORE</b>                           | <b>All students must take at least 3 courses in this area</b>                                       |   |   |   |
| NE 450 Principles of Nuclear Engr     | Not needed  | Required                                  | Required                                    | Required                                  |
| NE 565 Reactor Engr (Intermed NE)     | Required  | Required                                  | Required                                    | Required                                  |
| ME 540 Continuum Mechanics            | Strongly Encouraged   | Strongly Encouraged                       | Strongly Encouraged                         | Strongly Encouraged                       |
| ME 541 Mechanical Engr Analysis       | Required  | Required                                  | Required                                    | Required                                  |
| <b>SPECIALITY TRACKS</b>              | <b>All students must select at least one specialty track</b>  |   |   |   |
| <b>THERMOHYDRAULICS (TH)</b>          | Select at least 2 courses (including the required)  |   |   |   |
| NE 504 Nuclear Heat Transport         | Strongly Encouraged   |   |   |   |
| NE 570 Nuclear Chemical Engr          | Strongly Encouraged   |   |   | Required                                  |
| NE 575 Adv Nuclear Power Engr         | Required  | Required                                  | Required                                    | Required                                  |
| <b>NUCLEAR MATERIALS (NM)</b>         | Select at least 2 courses (including the required)  |   |   |   |
| ME 539 Adv Mech of Materials          |   |   |   |   |
| NE 538 Fundamentals/Nuclear Mtrls     | Required  | Required                                  | Required                                    | Required                                  |
| NE 537 Radiation Effects on Materials | Required  | Required                                  | Required                                    | Required                                  |
| NE 554 Radiation Det/Shielding        | Strongly Encouraged   | Strongly Encouraged                       | Strongly Encouraged                         | Strongly Encouraged                       |
| <b>FUEL REPROCESSING (FR)</b>         | Select at least 2 courses (including the required)  |   |   |   |
| NE 504 Molten Salt Technology         | Required  | Required                                  | Required                                    | Required                                  |
| NE 582 Spent Nuclear Fuel Disp/Mgt    | Required  | Required                                  | Required                                    | Required                                  |
| NE 585 Nuclear Fuel Cycles            |   |   |   |   |
| <b>THERMAL-FLUIDS</b>                 | Select at least 2 courses (including the required)  |   |   |   |
| ME 504 Advanced Heat Transfer         | Strongly Encouraged   | Strongly Encouraged                       | Strongly Encouraged                         | Strongly Encouraged                       |
| ME 520 Fluid Dynamics                 | Strongly Encouraged   | Strongly Encouraged                       | Strongly Encouraged                         | Strongly Encouraged                       |
| NE 530 Two-Phase Flow                 | Optional  | Optional                                  | Optional                                    | Optional                                  |
| <b>NUCLEAR CRITICALITY SAFETY</b>     | Select at least 3 courses (including the required). NCS certificate is also available in this area. |   |   |   |
| NE 535 Nuclear Criticality Safety I   | Required  | Required                                  | Required                                    | Required                                  |
| NE 555 Nuclear Criticality Safety II  | Required  | Required                                  | Required                                    | Required                                  |
| NE 533 Monte Carlo Methods            | Strongly Encouraged   | Strongly Encouraged                       | Strongly Encouraged                         | Strongly Encouraged                       |
| Advisor approved elective             |   |   |   |   |
|                                       |   |   |   |   |

| <b>SUGGESTED ELECTIVES</b>           | <b>Electives can be taken as part of the 30 credit minimum for the degree</b>  |                     |                     |                     |
|--------------------------------------|--|---------------------|---------------------|---------------------|
|                                      | Select from the list below and/or take any of the specialty track courses that are not in your focus area, check with your advisor before enrolling in elective courses. |                     |                     |                     |
| BUS 552 Mgt of Scientific Innovation |  |                     |                     |                     |
| CHE 590 Hydrogen Energy Systems      |  |                     |                     |                     |
| CHE 515 Transport Phenomena          |  |                     |                     |                     |
| CHEM 550 Radioanalytical Chemistry   |  |                     |                     |                     |
| CS 511 Parallel Programming          |  |                     |                     |                     |
| CS 576 Data Mining Topics/Tech       |  |                     |                     |                     |
| EM 510 Engineering Mgt Fundmntls     |  |                     |                     |                     |
| ENVS 583 Water and Energy Systems    |  |                     |                     |                     |
| MATH 432 Numerical Linear Algebra    |  |                     |                     |                     |
| ME 513 Engineering Acoustics         |  |                     |                     |                     |
| ME 526 Statistical Thermodynamics    |  |                     |                     |                     |
| ME 583 Reliability of Engr Systems   |  |                     |                     |                     |
| ME 552 TechVentures:HiTech Entrp     |  |                     |                     |                     |
| NE 501 Seminar                       | Strongly Encouraged  | Strongly Encouraged | Strongly Encouraged | Strongly Encouraged |
| NE 504 Fortran for Engineers         |  |                     |                     |                     |
| PHYS 550 Quantum Mechanics           | Permission Required  | Permission Required | Permission Required | Permission Required |
| PHYS 565 Particle/Nuclear Physics    | Permission Required  | Permission Required | Permission Required | Permission Required |
| PTTE 514 Nuclear Safety              |  |                     |                     |                     |
| PTTE 516 Nuclear Rules/Regulations   |  |                     |                     |                     |
| Advisor approved ISU courses         | Check with advisor regarding equivalencies and limits on transfer credits before enrolling   |                     |                     |                     |
| <b>THESIS OPTION</b>                 | <b>All thesis students must take 6-9 credits of research</b>   |                     |                     |                     |
| NE 500 Master's Research and Thesis  | Required   | Required            | Required            | Required            |
| <b>NON THESIS OPTION</b>             | <b>All non-thesis students must complete a capstone (i.e. comprehensive exam)</b>  |                     |                     |                     |
| Capstone (see advisor for details)   | Required   | Required            | Required            | Required            |

\*Courses may be delivered live, web, Engineering Outreach or hybrid. Check course schedule for delivery.

## 7.0 PH.D. DEGREE REQUIREMENTS & PROCEDURES

The applicant must satisfy the general requirements for the M.Engr. or M.S. degree in Nuclear Engineering. The additional details of the individual program for the Doctoral degree are established by each student's committee in consultation with the student. The general university guidelines require:

- A minimum of 78 credit hours beyond the Bachelor's degree
- At least 52 Upper Division credit hours (500 and above)
- Up to 45 credits can be 600 - Doctoral Research and Dissertation
- At least 39 of the 78 required credits must be after admission to the UI graduate program and be UI courses
- Of the 78 credits submitted to satisfy the degree requirements, a maximum of 30 credits may be more than eight (8) years old when the degree is conferred, provided the supervisory committee determines that the student has kept current in the subjects concerned.
- All other degree requirements must be completed no later than five (5) years after the date on which the candidate passed his/her preliminary examination.

Two examples of the requirements are given below. One example assumes the student completed a Master's thesis and the other assumes the student completed a non-thesis Masters.

### Completed Master's Thesis

#### **Course Work = 48 Credit Hours**

24 credits – M.S. course work

24 credits – Ph.D. course work

#### **Research = 30 Credit Hours**

6 credits - M.S. research & thesis

24 credits - Ph.D. research & dissertation

**Total Credit Hours = 78**

### Non-Thesis Masters

#### **Course Work = 51 Credit Hours**

30 credits – M.S. course work

21 credits – Ph.D. course work

#### **Research = 27 Credit Hours**

27 credits - Ph.D. research & dissertation

**Total Credit Hours = 78**

## 7.1 *Ph.D. Program*

Students interested in the program should contact the program director well in advance of the first registration for a tentative evaluation of educational preparation. Deficiencies in undergraduate course preparation for the graduate program will be identified. Students should review the [Faculty Research Areas](#) table and contact faculty with mutual research interests as well as the Program Director. (Appendix A)

## 7.2 Major Professor

A major professor will be selected by the department faculty at the time of the admissions file review. Matches will be based on the student's requests, academic background and research interests as well as the research initiatives and needs of the faculty. The major professor **should be formally appointed during the first semester of doctoral work**. Click [here](#) to go to form.

## 7.3 Qualifying Examination

The Ph.D. qualifying examination is administered twice a year (typically October and February). Students who have completed a significant amount of doctoral coursework may, after consultation with the major professor, request to take the exam. The NE Program Director, in coordination with NE Program Staff, announces the exam about one month prior to the exam. The student is to declare his/her intention to take the exam per email. The amount of time from admission to exam will vary based on credit load of the student and prior academic preparation. The exam is designed to evaluate preparation of doctoral coursework, and provide guidance in planning the Ph.D. program. It primarily tests nuclear engineering knowledge expected of a student degreed from an accredited undergraduate program. The exam is administered in Oral format but can have a written component and thus, requirement.

The review committee will consist of at least three persons (UI faculty or adjunct faculty) qualified to examine the student on traditional nuclear engineering curricular topics as well as at the advanced undergraduate level of achievement in the following areas:

### ENERGY

1. Thermodynamics, Heat Transfer, and Fluid Mechanics
2. Course preparation
  - a) Engr 320, ME 345
  - b) Engr 335 or equivalent

### CHEMISTRY & PHYSICS

3. Principles of Chemistry and Modern Physics
4. Course preparation
  - a) CHEM 112
  - b) PHYS 305 or equivalent

### MATHEMATICS

5. Numerical Methods and Computer Programming Language(s)
6. Course preparation
  - a) Math 310
  - b) Math 275
  - c) Additional computer and mathematics experience

The Program Director, in consultation with the major professor, will appoint the examiner(s) in each area. The student may, at the discretion of the examining committee, be exempted from the written part of the examination because of exemplary performance on the oral portion. The

examining committee can also recommend additional courses, for credit or audited, to make up for deficiencies and weaknesses demonstrated.

The dates for the Oral Examination are to be arranged with the Nuclear Engineering Program Director. Exams dates are usually prior to the midterm of the fall and spring semesters.

The results of the Qualifying Examination must be communicated to the Program Director in a memo from the chair of the examination committee. Each student will then be formally notified of the results of his/her exam.

#### *7.4 Doctoral Committee*

The student's doctoral committee will be discussed by the student and major professor in consultation with the program director. The Committee must include:

- ✓ Major professor (Chair)
- ✓ One member from the Nuclear Engineering faculty (Inside Member)
- ✓ One member from a supporting field or from within the department (Inside/Outside Member)
- ✓ One member from outside the major field (Outside Member)

The Chair must be UI faculty, the Inside Member may be UI faculty or eligible adjunct faculty members. Additional members may be appointed if desired. It is recommended that students have only 4 members. An outside member from another institution may be approved if graduate faculty at that institution and if the department determines that he or she is appropriate for the student's committee. At least fifty percent (50%) of the committee members must be members of the graduate faculty.

#### *7.5 Study Plan*

Your Study Plan should be prepared **by the time three classes are completed**. The major professor, department and graduate Dean approve the study plan and it is then submitted by the student through [VandalWeb](#). The major professor must be listed on VandalWeb, before the plan can be approved. Students are encouraged to create a draft prior to this. Faculty members on the committee are expected to have input on the study plan development.

#### *7.6 Preliminary Examination*

When a majority of the course requirements on the study plan have been completed, a preliminary exam, written and/or oral, will be given under the direction of the student's major professor. In Nuclear Engineering, the Committee administers this examination with emphasis

on the course work in the major area and the student's research proposal. All committee members must participate in the examination.

The student may be required to complete an 8 hour written examination on graduate level concepts in either open or closed book form at the discretion of the supervisory committee or 2 hour oral examination may be taken. Broad areas to be covered are those listed in the study plan. Upon successful completion of the exam, the student is advanced to candidacy.

### *7.7 Dissertation Proposal*

The examination includes presentation of a written dissertation proposal and/or progress report to the committee. Committee members will sign and date the front page of the proposal, indicating acceptance. Upon successful completion of the Preliminary Examination, the student is advanced to candidacy.

The presentation of the doctoral proposal and the preliminary examination may, at the committee's discretion, occur at the same time and in a condensed time frame. The entire committee must participate in the dissertation proposal meeting.

### *7.8 Report of Preliminary Examination & Advancement to Candidacy Form*

This form will be completed and submitted to the College of Graduate Studies by the major professor on completion of the exam and presentation.

### *7.9 Request to Proceed to Final Defense*

After detailed consultations with the major professor, the candidate provides each committee member with a copy of the dissertation that will be defended. It is recommended that the committee be given 4-6 weeks to review the study.

Students must schedule the defense meeting with the committee members and then collect each member's signature on the Request to Proceed with Final Defense Form. The student must submit the signed form to the College of Graduate Studies 10 business days prior to the defense meeting. The entire committee must participate in the dissertation defense.

### *7.10 Doctoral Dissertation Defense*

The defense consists of 20-30 minutes of presentation with professional appearance scholarly slides. After the candidate's presentation, the major professor will facilitate the questioning of the candidate by the committee. The committee will then deliberate in a private session to determine the outcome of the defense. Upon completion of the deliberation, the candidate will meet with the committee in a private session to learn the committee's decisions on further

research or edits needed. If the defense is not acceptable to the majority of the committee, a new defense must be scheduled after the changes are made.

It is imperative that students follow the guidelines and instructions set forth for Thesis Defense. Please review the following prior to beginning the thesis to ensure compliance with all requirements.

- ✓ [Deadlines to submit Thesis, Dissertations and Non-Thesis Report Forms](#)
- ✓ [Tips for Starting \(And Finishing!\) Your Thesis or Dissertation](#)
- ✓ [Master's Thesis Proposal Instructions](#)
- ✓ [Handbook for Writing Thesis & Dissertations](#)

Further information on university and general regulations, including required forms and Graduate Handbook for Theses and Dissertations, is available from the University of Idaho, [College of Graduate Studies](#) and the [Registrar](#).

Dissertation defenses are open to the public including other faculty and students.

### *7.11 Submission of Final Dissertation*

Complete instructions for formatting and submission are found in the [Graduate Handbook for Theses and Dissertations](#). It is important to follow the instructions to the letter.

Further information on university and general regulations may be found, including the Graduate Handbook for Theses and Dissertations and forms, from the University of Idaho [College Of Graduate Studies](#) or the [Registrar](#).

## 8.0 NUCLEAR ENGINEERING DOCTORAL DEGREE COURSE PLAN – 78 CREDITS

Prerequisites may need to be taken prior to enrolling in these courses. Check [www.uidaho.edu/registrar](http://www.uidaho.edu/registrar), catalogs.

| **Courses                             | Master's Degree in Nuclear Engineering  | Degree in Physics or Chemistry | Degree in Mechanical Engineering | Degree in Chemical Engineering |
|---------------------------------------|---|--------------------------------|----------------------------------|--------------------------------|
| <b>CORE</b>                           |   |                                |                                  |                                |
| NE 450 Principles of Nuclear Engr     | Not needed  | Required                       | Required                         | Required                       |
| NE 565 Reactor Engr (Intermed NE)     | Not needed  | Required                       | Required                         | Required                       |
| ME 540 Continuum Mechanics            | Strongly Encouraged   | Strongly Encouraged            | Required if not taken in M.S.    | Strongly Encouraged            |
| ME 541 Mechanical Engr Analysis       | Required  | Required                       | Required if not taken in M.S.    | Required                       |
| <b>SPECIALITY TRACKS</b>              | <b>All students must select at least one specialty track</b>  |                                |                                  |                                |
| <b>THERMOHYDRAULICS (TH)</b>          | Select at least 2 courses (including the required)  |                                |                                  |                                |
| NE 504 Nuclear Heat Transport         | Strongly Encouraged   |                                |                                  |                                |
| NE 570 Nuclear Chemical Engr          | Strongly Encouraged   |                                |                                  | Required                       |
| NE 575 Adv Nuclear Power Engr         | Required if not taken in M.S.   | Required                       | Required                         | Required                       |
| <b>NUCLEAR MATERIALS NM)</b>          | Select at least 2 courses (including the required)  |                                |                                  |                                |
| ME 539 Adv Mech of Materials          |   |                                |                                  |                                |
| NE 538 Fundamentals/Nuclear Mtrls     | Required  | Required                       | Required                         | Required                       |
| NE 537 Radiation Effects on Materials | Required  | Required                       | Required                         | Required                       |
| NE 554 Radiation Det/Shielding        | Strongly Encouraged   | Strongly Encouraged            | Strongly Encouraged              | Strongly Encouraged            |
| <b>FUEL REPROCESSING (FR)</b>         | Select at least 2 courses (including the required)  |                                |                                  |                                |
| NE 504 Molten Salt Technology         | Required  | Required                       | Required                         | Required                       |
| NE 582 Spent Nuclear Fuel Disp/Mgt    | Required  | Required                       | Required                         | Required                       |
| NE 585 Nuclear Fuel Cycles            |   |                                |                                  |                                |
| <b>THERMAL-FLUIDS</b>                 | Select at least 2 courses (including the required)  |                                |                                  |                                |
| ME 504 Advanced Heat Transfer         | Strongly Encouraged   | Strongly Encouraged            | Strongly Encouraged              | Strongly Encouraged            |
| ME 520 Fluid Dynamics                 | Strongly Encouraged   | Strongly Encouraged            | Strongly Encouraged              | Strongly Encouraged            |
| NE 530 Two-Phase Flow                 | Optional  | Optional                       | Optional                         | Optional                       |
| <b>NUCLEAR CRITICALITY SAFETY</b>     | Select at least 3 courses (including the required). NCS certificate is also available in this area. |                                |                                  |                                |
| NE 535 Nuclear Criticality Safety I   | Required  | Required                       | Required                         | Required                       |
| NE 555 Nuclear Criticality Safety II  | Required  | Required                       | Required                         | Required                       |
| NE 533 Monte Carlo Methods            | Strongly Encouraged   | Strongly Encouraged            | Strongly Encouraged              | Strongly Encouraged            |
| Advisor approved elective             |   |                                |                                  |                                |

| SUGGESTED ELECTIVES                  | Electives can be taken as part of the doctoral degree.   |                     |                     |                     |
|--------------------------------------|--|---------------------|---------------------|---------------------|
|                                      | Select from the list below and/or take any of the specialty track courses that are not in your focus area, check with your advisor before enrolling in elective courses. |                     |                     |                     |
| BUS 552 Mgt of Scientific Innovation |  |                     |                     |                     |
| CHE 590 Hydrogen Energy Systems      |  |                     |                     |                     |
| CHE 515 Transport Phenomena          |  |                     |                     |                     |
| CHEM 550 Radioanalytical Chemistry   |  |                     |                     |                     |
| CS 511 Parallel Programming          |  |                     |                     |                     |
| CS 576 Data Mining Topics/Tech       |  |                     |                     |                     |
| EM 510 Engineering Mgt Fundmntls     |  |                     |                     |                     |
| ENVS 583 Water and Energy Systems    |  |                     |                     |                     |
| MATH 432 Numerical Linear Algebra    |  |                     |                     |                     |
| ME 513 Engineering Acoustics         |  |                     |                     |                     |
| ME 526 Statistical Thermodynamics    |  |                     |                     |                     |
| ME 583 Reliability of Engr Systems   |  |                     |                     |                     |
| ME 552 TechVentures:HiTech Entrp     |  |                     |                     |                     |
| NE 501 Seminar                       | Strongly Encouraged  | Strongly Encouraged | Strongly Encouraged | Strongly Encouraged |
| NE 504 Fortran for Engineers         |  |                     |                     |                     |
| PHYS 550 Quantum Mechanics           | Permission Required  | Permission Required | Permission Required | Permission Required |
| PHYS 565 Particle/Nuclear Physics    | Permission Required  | Permission Required | Permission Required | Permission Required |
| PTTE 514 Nuclear Safety              |  |                     |                     |                     |
| PTTE 516 Nuclear Rules/Regulations   |  |                     |                     |                     |
| Advisor approved ISU courses         | Check with advisor regarding equivalencies and limits on transfer credits before enrolling   |                     |                     |                     |
| DISSERTATION                         |  |                     |                     |                     |
| NE 600 Research and Dissertation     | Required   | Required            | Required            | Required            |

\*The 78 credits minimum is what it required as a baseline for a doctoral degree. Students who do not have a degree/background in their selected research area may need to take additional coursework in preparation for the dissertation research.

\*\*Courses may be delivered live, web, Engineering Outreach or hybrid. Check course schedule for delivery.

## 9.0 INTERNATIONAL STUDENTS

International graduate students must carry nine (9) credit hours per semester to be in compliance with the rules and regulations of the U.S. Immigration Service. The University of Idaho [International Programs Office](#) is available to answer questions about this requirement.

Alice Allen  
Designated School Official, Academic Program Coordinator  
(208) 282-7816  
[alicew@uidaho.edu](mailto:alicew@uidaho.edu)

Tammi Johnson  
International Student, Scholar and Faculty Services Coordinator  
(208) 885-8945  
888-884-3246 (toll free from within the U.S.)  
[tammir@uidaho.edu](mailto:tammir@uidaho.edu)

Huiran (Ashley) Ding  
Program Coordinator  
(208) 885-5113  
888-884-3246 (toll free from within the U.S.)  
[hding@uidaho.edu](mailto:hding@uidaho.edu)

## 10.0 GRADUATE COURSE OFFERINGS

University of Idaho (UI) and Idaho State University (ISU) cooperate in supporting the graduate degree programs and course offerings at both institutions. UI graduate students, may enroll in ISU nuclear engineering courses. Students should gain approval of their major professor prior to enrolling in a course. Most courses offered at the University of Idaho in Idaho Falls are in the evening and are held in the Center for Higher Education (CHE) or the Tingey Administration Building (TAB). On a limited basis courses are held at the Center for Advanced Energy Studies (CAES).

[University of Idaho Class Schedule](#)

[University of Idaho Three-Year Plan](#)

## 11.0 RESEARCH & TEACHING ASSISTANTSHIPS

Competitive research and instructional assistantships may be available to fully admitted full-time students. Funding is limited and varies from semester to semester. Early application for admission is strongly recommended. After admission contact Program Director for application details. Students must meet milestone performance expectations and other academic progress in order for funding to continue.

Students on assistantship must be enrolled in a minimum of 9 credit hours during the fall and spring semesters and work 20 hrs per week on their funded research project. During the summer session graduate assistants may be hired as temporary help and may be eligible to work up to a full 40 hours per week. Summer registration for Master's Research and Thesis (500) or Doctoral Research and Dissertation (600) is expected of all graduate students who are working on the thesis or dissertation. . International students should consult with their advisor and International Programs regarding the number of credits required for summer registration.

Assistantships are very competitive at the University of Idaho. Funding for projects is very competitive and timing is important. It is important to stay in close contact with your advising professor if you have interest in an assistantship. Graduate assistants are paid hourly for hours worked and in most cases tuition, fees and health insurance are paid for the student as well. This compensation is intended to allow the student to maintain a basic standard of living while completing their graduate studies.

An assistantship is a job with employment requirements and employer expectations. Graduate students who accept an assistantship must satisfactorily meet all employment and employer expectations or the assistantship funding may be withdrawn. Expectations include many items such as payroll forms and reporting and completion of research project milestones. The job is not intended to be hours spent doing homework, working on the thesis or dissertation or handling other personal tasks. Those activities should be completed outside of the paid hours of the assistantship job.

### 11.1 *Center for Advanced Energy Studies (CAES)*



The Center for Advanced Energy Studies (CAES) is a public/private partnership between the State of Idaho through its academic research institutions, Boise State University (BSU), Idaho State University (ISU), the University of Idaho (UI), and the federal government through the

Department of Energy and its Idaho National Laboratory (INL), which is managed by a private entity, Battelle Energy Alliance (BEA). Through its collaborative structure, CAES combines the efforts of these four research institutions to provide timely research support on both technical and policy issues.

CAES partners leverage their resources, capabilities, and expertise in collaboration with others to provide:

**Research**

Deliver innovative, cost-effective, credible research that meets the demands of a carbon-constrained world.

**Education**

Educate the next generation of energy scientists, policy makers and the public while accepting and leveraging the values of those groups.

**Policy**

Facilitate an informed dialogue involving the scientific community, the public, and government; leading to energy policy at a national, regional and State level.

## Appendix A

### Nuclear Engineering Program Faculty Research Areas

#### **Idaho Falls Faculty**

**Akira Tokuhiro Ph.D.** - NE Program Director, Associate Professor, Mechanical Engineering (208) 533-8102 [tokuhiro@uidaho.edu](mailto:tokuhiro@uidaho.edu)

Thermo-fluid sciences, experiments, nuclear reactor engineering, design and safety, thermohydraulics, convective heat transfer, applied biometrics, energy processes modeling, computational fluid dynamics , applications of silica and polymer gels.

**Aydogan, Fatih, Ph.D.** – Assistant Professor, Mechanical Engineering (208)\_ 533-8107 [fatih@uidaho.edu](mailto:fatih@uidaho.edu)

Small modular and advanced reactors, system design and analysis, nuclear safety, computational and experimental thermal hydraulics

**Donald McEligot Ph.D.,** - Adjunct Faculty, Mechanical Engineering (208) 533-8120 [donaldm@uidaho.edu](mailto:donaldm@uidaho.edu)

Thermal science: convective heat transfer, fluid mechanics, turbulent, laminar and transitional shear flow: experimental, analytical and computational.

**Supathorn Phongikaroon Ph.D.,** - Assistant Professor, Chemical Engineering (208) 533-8123 [supathor@uidaho.edu](mailto:supathor@uidaho.edu)

Pyroprocessing technology--theoretical and experimental studies in electrorefinery, oxide reduction and chemistry, and ion exchange. Interfacial phenomena and multiphase flow systems involving in nuclear and chemical engineering applications.

**Ali Siahpush Ph.D.** - Adjunct Faculty, Mechanical Engineering (208) 526-8708 [Ali.Siahpush@inl.gov](mailto:Ali.Siahpush@inl.gov)

Solidification and melting (in presence of natural convection in liquid) with internal heat generation.

#### **Moscow Faculty**

**Thomas E. Bitterwolf Ph.D.,** - Professor, Chemistry [bitterte@uidaho.edu](mailto:bitterte@uidaho.edu)

Hydrogen production, development of novel catalytic materials for the electrolysis of water, generation of ammonia from hydrogen as transportable hydrogen material.

**Indrajit Charit Ph.D.,** - Assistant Professor , Materials Science & Engineering (208) 885-5964 [icharit@uidaho.edu](mailto:icharit@uidaho.edu)

Microstructure- Property Correlations, Nuclear Materials, High Temperature Mechanical Behavior of Materials (Creep, Superplasticity, Creep-Fatigue), Nanocrystalline Materials, Advanced Processing Techniques (Mechanical Alloying, Friction Stir Processing), Light Metals, Multi-functional Materials.

**John Crepeau Ph.D.**, Mechanical Engineering Chair, Professor, Mechanical Engineering  
(208) 885-5228 [crepeau@uidaho.edu](mailto:crepeau@uidaho.edu)

Transition to turbulence in fluid flow and fluid stability; flow visualization; experimental and theoretical studies of drying and drying processes. Solidification of materials with internal heat generation.

**Ruprecht Machleidt Ph.D.**, - Professor, Physics  
(208) 885-8951 [machleid@uidaho.edu](mailto:machleid@uidaho.edu)

Theoretical nuclear physics, theory of nuclear forces and nuclear matter, theoretical modeling of any kind.

**Gabriel (Gabe) Potirniche Ph.D.**, - Assistant Professor. Mechanical Engineering  
(208) 885-4049 [gabrielp@uidaho.edu](mailto:gabrielp@uidaho.edu)

Fatigue and fracture, constitutive modeling for metals and polymers, dynamic and impact loading, atomistic simulations, crystal plasticity, anisotropic plasticity, finite element method, solid mechanics

**Vivek Utgikar Ph.D.**, Associate Professor, Chemical Engineering  
(208) 885- 6970 [vutgikar@uidaho.edu](mailto:vutgikar@uidaho.edu)

Development of energy utilization systems - nuclear hydrogen production, utilization and safety; reactor-hydrogen production interface; energy analysis; electrochemical engineering and fuel cells.

**Chien Wai Ph.D.**, Professor, Chemistry  
[cwai@uidaho.edu](mailto:cwai@uidaho.edu)

Supercritical fluid extraction; nanomaterials synthesis; environmental chemistry; separation chemistry.

### **Boise Faculty**

**Ralph Budwig**, Mechanical Engineering, Professor  
[rbudwig@uidaho.edu](mailto:rbudwig@uidaho.edu)

Experimental and theoretical fluid dynamics; turbulence; optical, acoustic, and thermal measurements techniques and experimental methods; laboratory pedagogy.

## Appendix B

### Forms, Handbooks & Links

|  |   |
|--|---|
| Center for Advanced Energy Studies (CAES)      | <a href="https://inlportal.inl.gov/portal/server.pt?open=512&amp;objID=281&amp;parentname=CommunityPage&amp;parentid=4&amp;mode=2&amp;in_hi_userid=200&amp;cached=true">https://inlportal.inl.gov/portal/server.pt?open=512&amp;objID=281&amp;parentname=CommunityPage&amp;parentid=4&amp;mode=2&amp;in_hi_userid=200&amp;cached=true</a> |
| College of Graduate Studies (COGs)             | <a href="http://www.uidaho.edu/cogs/">www.uidaho.edu/cogs/</a>  |
| Faculty Research Areas                         | <a href="http://www.uidaho.edu/idahofalls/nuclearengineering/nefaculty">www.uidaho.edu/idahofalls/nuclearengineering/nefaculty</a>  |
| General Catalog                                | <a href="http://www.uidaho.edu/registrar/classes/catalogs">www.uidaho.edu/registrar/classes/catalogs</a>  |
| Graduate Admission                             | <a href="http://www.uidaho.edu/graduateadmissions">www.uidaho.edu/graduateadmissions</a>  |
| Graduate Forms, Guides & Handbooks             | <a href="http://www.uidaho.edu/cogs">www.uidaho.edu/cogs</a>  |
| Idaho National Laboratory (INL)                | <a href="http://www.inl.gov/">www.inl.gov/</a>  |
| International Programs Office                  | <a href="http://www.uidaho.edu/international">www.uidaho.edu/international</a>  |
| Office of the Registrar                        | <a href="http://www.uidaho.edu/registrar">www.uidaho.edu/registrar</a>  |
| Student Code of Conduct                        | <a href="http://www.uidaho.edu/DOS/judicialaffairs/studentcodeofconduct">www.uidaho.edu/DOS/judicialaffairs/studentcodeofconduct</a>  |
| UI Idaho Falls Three Year Plan                 | <a href="http://www.uidaho.edu/~media/Files/Centers/IDAHOFALLS/3yrPlanNov2009.ashx">www.uidaho.edu/~media/Files/Centers/IDAHOFALLS/3yrPlanNov2009.ashx</a>  |
| TOEFL  | <a href="http://www.ets.org/toefl">www.ets.org/toefl</a>  |
| University of Idaho-Idaho Falls Class Schedule | <a href="http://www.uiweb.uidaho.edu/schedule/if/schedule.htm">www.uiweb.uidaho.edu/schedule/if/schedule.htm</a>  |
| Vandal Accounts                                | <a href="http://www.vandalsetup.uidaho.edu">www.vandalsetup.uidaho.edu</a>  |
| Vandal Web                                     | <a href="http://www.vandalweb.uidaho.edu/">www.vandalweb.uidaho.edu/</a>  |

## **APPENDIX C**

### Learning Outcomes of the Nuclear Engineering Program

1. Graduates of the program will communicate professionally and effectively in written and oral presentations to a technical audience
2. Graduates of the program will be able to identify and analyze engineering problems through multidisciplinary approaches. Graduates of the program will be collaborative problem solvers who can synthesize and apply advanced mathematics, science and engineering.
3. Graduates of the program will be effective nuclear engineers capable of utilizing existing research as the basis for making sound decisions to carry an engineering project through the conceptual, design and implementation phases. They will be capable of performing original scholarly work and consider the impact of the application of both new and existing research on society.
4. Graduates of the program will demonstrate awareness of the global nature of the practice of nuclear engineering and be responsible for the role that they play in enhancing the quality of life of the global community. They will continually strive for an openness to lifelong learning.
5. Graduates of the program will practice ethical leadership in seeking collaborative Solutions and fostering respect for diversity of thought. They will actively participate in initiatives that add to the body of knowledge and practice and engage the future generations of engineers.