

**The University of Florida, Department of Materials Science and Engineering  
Nuclear Engineering Program**

**ENU 4180: Introduction to the Nuclear Fuel Cycle**

**Class Periods:** T 1250-1445 & R 1250-1340

**Location:** T: TUR 2352 & R: MAEB 0238

**Academic Term:** Spring 2026

**Catalog Description:** Fuel cycle from mining through waste management including economics and policy concerns/constraints. Physical and chemical processes in the conventional nuclear fuel cycle: uranium mining and milling, conversion, enrichment, fuel fabrication, reactor operations, interim storage, reprocessing and recycling, waste treatment and disposal. Nonproliferation, nuclear forensics, alternative fuel cycles and future prospects will also be considered.

***Statement Related to Policy for Co-Listed Graduate/Undergraduate Courses***

To uphold the integrity of the graduate program by ensuring that students who receive graduate credit are completing graduate-level work and to guarantee that students receiving undergraduate credit are not held to graduate level standards, separate requirements exist for the co-listed graduate and undergraduate nuclear fuel cycle courses.

Students enrolled in the graduate course will have the following requirements imposed on them in addition to those present for the undergraduate course:

- Additional complexity in the form of more involved and additional cases to consider for modeling, simulation, and experimental data analysis problems, for example.
- Students enrolled in the graduate course will be required to present a one-hour lecture on a pre-approved special topic related to the nuclear fuel cycle and will be assessed based on a jointly developed rubric.
- Students enrolled in the graduate course will have additional problems and/or more challenging problems on assigned homework, quizzes, and exams.
- Students enrolled in the graduate course will be responsible for learning and implementing advanced simulation and modeling codes to solve problems in assigned projects, homework, and exams.
- Students enrolled in the graduate course will be assessed on more demanding performance criteria.

All students in the co-listed courses will be held to the same standards regarding attendance, academic honesty, and general class expectations.

**Credit:** 3 hours

**Instructor:** Prof. Kyle C. Hartig, [kyle.hartig@ufl.edu](mailto:kyle.hartig@ufl.edu)  
210 MAE; 352-392-4907  
*Office hours:* TBD

Note: Office hours will be offered in my office. Office hours may change due to conflicts (e.g., travel schedule) and will be scheduled the first week of class.

Note: For all course-related questions a preferred mode of interaction is to visit with the professor during office hours or during class and refrain from using email.

**Teaching Assistant/Supervised Teaching Student:** None

**Required Textbooks and Software:**

- N. Tsoulfanidis, *Nuclear Fuel Cycle*, American Nuclear Society, 2012 (978-0894484605)  
 Available for free through the university library (<https://app.knovel.com/s.v?nbyClfxP>).  
 MCNP 6.3.1 and SCALE available for free by request on RSICC  
 (<https://rsicc.ornl.gov/Default.aspx>) See canvas page for details.  
 Chart of Nuclides: You will need access to a chart of nuclides during the course. Feel free to use any one of the numerous resources available (so long as it is accurate). Below are a couple of suggested charts of nuclides.  
 I. Joseph R. Parrington, et al., *Nuclides and Isotopes*, 15th Ed., Lockheed Martin/GE Nuclear, 1996.  
 II. <http://atom.kaeri.re.kr> (Recommended)

#### Recommended:

- I. T. Pigford *et al.*, *Nuclear Chemical Engineering*, McGraw-Hill 1981 (978-0070045316)
  - II. Kenneth S. Krane, *Introductory Nuclear Physics*, Third Edition 1988, John Wiley & Sons (978-0471805533)
  - III. Shultis and Faw, *Fundamentals of Nuclear Science and Engineering*, Second Edition 2007, CRC Press (978-1420051353)
  - IV. Neutronics texts (such as from ENU 4103, 4104, or 6106)
- Other online and print resources will be given out during lecture and on the Canvas site.*

#### Pre-requisites and Co-requisites:

Pre-requisite: ENU 4103 (i.e., senior status in nuclear engineering)

#### Course Objectives:

- (i) Provide students with the opportunity to learn fundamental and applied principles of the nuclear fuel cycle;
- (ii) Provide students with an understanding of relevant codes/packages available for analysis of nuclear fuel cycle processes;
- (iii) Development of communication skills including technical writing and oral presentations;
- (iv) Prepare students for independent research and/or design projects.

#### Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Low
3. An ability to communicate effectively with a range of audiences	High
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	High
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

\*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

**Material and Supply Fees:** None.

**Web Tools:** <https://ufl.instructure.com/>

The course Canvas site will be used to distribute the syllabus, grades, and lecture materials. Additionally, the course Canvas site may be used to distribute quizzes, discussion topics, exams, projects, and all other course material. The site will be used to provide announcements. It is your responsibility to regularly check the course site as well as your email for any alerts to changes in the site or new announcements. I may place course notes ahead of lectures on Canvas. The notes I may post may only contain fragments of the entire lecture.

**Meeting Times & Location:**

See header of first page.

**Course Schedule** (subject to adjustments throughout semester)

Note: Adjustments to this regular schedule could be made periodically and announced in advance in class and/or through the class website/email.

Discussion board and in-class topics, participation activities, and short quizzes will occur on a nearly weekly basis, either through the Canvas course page or in person. All activities will emphasize the development of professional skills for nuclear engineers pursuing careers in industry and/or research. Throughout the term, special guest lectures by UF faculty and external researchers, engineers, and policymakers will be offered and will be available for synchronous or asynchronous viewing on the Canvas course page. Several individual and group projects will be assigned over the course of the semester; some may include intermediate due dates to encourage timely completion and progress toward course objectives.

**Jan 13 & 20:** Introduction and Front-End Overview

**Jan 20 & 22:** Core Design Criteria – Physics and Engineering and In-Core Aspects

**Jan 27 & 29:** Reactor Types (e.g., HTGR, Fast Reactors, CANDU, LWR, etc.) – **HW 1 Due**

**Feb 3 & 5:** Fuel Manufacturing and Engineering, Design & Fuel Performance During Irradiation –

**Feb 10 & 12:** Fuel Cycle, Operations, and Economics

**Feb 17 & 19:** Back-End Overview – **HW 2 Due**

**Feb 24 & 26:** Options for Actinide Management, Waste Classification, and Regulation

**Mar 3 & 5:** Actinide Separation Technology I

**Mar 10 & 12:** Actinide Separation Technology II – **HW 3 Due**

**March 17 & 19:** **Spring Break**

**Mar 24 & 26:** Proliferation and Safeguards

**Mar 31 & Apr 2:** Nuclear Security & Nonproliferation – **HW 4 Due**

**Apr 7 & 9:** Fuel Cycle Systems Simulation

**Apr 14 & 16:** Advanced Computational Tools for Fuel Cycle Analysis – **HW 5 Due**

**Apr 21:** Project Presentations

**Week of Apr 27:** Final – 4/29/2026 @ 5:30 PM - 7:30 PM.

### Grading Scale

The final grades will be assigned based on:

- A:  $\geq 92\%$
- A-:  $\geq 88\%$
- B+:  $\geq 84\%$
- B:  $\geq 80\%$
- B-:  $\geq 76\%$
- C+  $\geq 72\%$
- C:  $\geq 68\%$
- C-:  $\geq 65\%$
- D+:  $\geq 62\%$
- D:  $\geq 59\%$
- D-:  $\geq 56\%$
- E:  $< 56\%$

Please note that following:

1. At the end of the course, students overall course grades may be curved up at my discretion.
2. Grading in this course is “plus-based”. That is, I award you points based on correct steps, rather than deducting points for errors.
3. There is no general protection against double jeopardy. Points are often allocated, particularly on exams, to each specific step and to obtaining the final, correct answer in each problem – a single error will prevent you from earning points at that step and for the final answer.
4. The grade cut-offs for A, B, and C are somewhat lower than the “high-school scale” (90, 80, 70, etc.) under which many UF courses and syllabi templates operate. This is not to grant inflated letter grades but rather to account for the challenging nature of the course material and to appropriately award genuinely excellent performances.

**Grading:** Below is a breakdown for the grading in the lecture:

Homework(s) - 25% (will be five)

Quizzes - 20% (up to six)

Projects - 40% (will be two)

Final Exam - 15%

*Important Note:* Students enrolled in ENU 5186 will complete additional, more advanced assignment problems. 5186 course work is graded separately from the undergraduate course.

**Grade Appeal:** All appeals of grades, including those from clerical/grade-calculation errors, must be made within one week of return. (This may be modified for specific assignments near the end of the term. I will announce this via e-mail as needed.)

Grade appeals must be provided in the following format:

- Include your entire assignment unmodified.
- Attach (paper clip preferred) a written summary of which problem(s) or part(s) you believe were graded inaccurately. Be as specific as possible.
- Turn in your appeal to me (virtually or in-person) at class time or during office hours.

I will review your grade appeal, contact you via your ufl.edu e-mail address, and return the assignment in class. Fairly simple appeals provided to me during office hours may be decided upon while you wait, at my discretion.

Appeals will be considered for clerical errors, addition errors, and inconsistent scoring. Grade appeals will not be entertained if you simply do not like that (for example) Part 1 was worth only 2 points with Part 2 worth 5 points.

On very rare occasions, if I believe the student is not acting in a good faith belief that more points are deserved, I will deem the appeal frivolous. Following two frivolous appeals, your grade appeal privilege through this method will be revoked. Further appeals must be done through the petitions process, which requires formal paperwork and department/program level involvement.

### ***Required Computer***

Recommended Computer Specifications: [https://it.ufl.edu/get-help/student-computer-recommendations/HWCOE Computer Requirements](https://it.ufl.edu/get-help/student-computer-recommendations/HWCOE%20Computer%20Requirements): <https://www.eng.ufl.edu/students/advising/fall-semester-checklist/computer-requirements/>

### ***Use of AI Tools***

Generative-AI platforms (e.g., ChatGPT, Grok, GitHub Copilot, Claude) may be used in this course for idea generation, editing, debugging, or study support, provided you: (1) evaluate and verify all content the tool produces, (2) ensure the final submission represents your own understanding and analytical effort, and (3) disclose any substantive AI assistance (tool, date, and purpose) in a brief footnote or code comment. Unattributed or wholesale adoption of AI output, or use that circumvents learning objectives, constitutes academic misconduct under the UF Honor Code. Remember that AI models can fabricate references, misstate facts, and reproduce copyrighted or biased material; you are responsible for the accuracy, originality, and ethical integrity of everything you submit. Questions about appropriate use will be discussed in class as AI capabilities and university guidance evolve.

### **Attendance**

Students shall attend each lecture in-person as quizzes, in-class work, and homework will occur sporadically throughout the semester based on the posted lecture materials. If the student must miss a class for an appropriate reason, it should be brought to the attention of the instructor as far in advance as possible.

If a student arrives late or leaves early, they are expected to do so with minimum level of disruption to the class in progress (primarily for presentations and panels). There is no tolerance for mobile phones or other electronic disruptions. Such disruptions will lead to the student being told to leave the room for the duration of the class period, including during examination periods.

### **Make Up Work:**

Late-work excuses can be grouped into the categories of professional, medical, and personal.

*Professional:* Reasonable extensions for job/internship interviews, technical conferences, or other professional/career development reasons should be requested. Requests are typically granted, at my discretion, unless they would grant a student or group of students an unfair advantage over their peers, cause significant disruption to the course or grading schedule, or violate some UF policy.

*Medical:* Extensions will also be granted for (your own) medical reasons – please do not come to class if you are ill. Per UF policy, in the case of medical absences that are frequent or suspiciously- timed (e.g.; you are repeatedly, suddenly ill at deadlines), I may request a signed note from a physician or similar professional practitioner.

*Personal:* In addition, UF policies require accommodation for several non-academic, non- medical reasons. Extensions for these personal issues are strictly limited to those mandated by the letter of UF policies. If you have a question regarding your personal issue and if it qualifies under one of the excused absence/late-work policies, contact me in advance.

### **Collaboration**

The ground rules for collaboration should be decided by each group through compromise and consensus. However, regardless of the preferences of the group as a whole, each student retains the individual right to privacy and to maintain good mental and physical health. To this end, no student shall be compelled:

- To join a real-name social networking site or modify their existing use of such a site, or
- To accept a 24/7 or another onerous on-call policy.

That is: each member holds a unilateral veto on using Facebook (or some such) for your group's work or for being contacted at all hours of the day and night.

Inter-personal issues within your group stemming from deciding group rules must be brought to me promptly for arbitration. This arbitration will focus on the guidelines above and in forming an equitable compromise (essentially, equal marginal/new inconvenience) among group members and not on determining whose activities outside this course (including personal pursuits, situations, and choices) are more meritorious.

The allowed level of collaboration on homework may vary and is specified on the assignment.

### ***Academic Policies & Resources***

To support consistent and accessible communication of university-wide student resources, instructors must include this link to academic policies and campus resources: <https://go.ufl.edu/syllabuspolicies>. Instructor-specific guidelines for courses must accommodate these policies.

### ***Commitment to a Positive Learning Environment***

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values.

If you feel like your performance in class is being impacted, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWCOE Human Resources, 352-392-0904, [student-support-hr@eng.ufl.edu](mailto:student-support-hr@eng.ufl.edu)
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, [pld@ufl.edu](mailto:pld@ufl.edu)

### ***Changes to Syllabus***

Changes to this syllabus will be provided via the Canvas platform. Such changes may include those required by policy changes, my travel, changes in the speed of course coverage, university closure, errors in previous syllabus versions, and other reasons.

### ***Change Log***

V1.0 – Original Version