

Nuclear Power Plant Reactor Systems 1  
ENU 4144, Section 13516, Spring 2019  
T 1355-1445 (UF “Period” 6) in TBD, R 1250-1445 (UF “Periods” 6-7) in TBD  
Final Exam: April 30, 2020, 0730-0930 (To be confirmed)

## Instructor

DuWayne Schubring, Associate Engineer  
315 Materials Engineering Building (MAE). Enter through 317 MAE.  
352-294-7870

dlschubring@ufl.edu (This is the best way to reach me. The Canvas “conversations” feature *is not* e-mail. Messages sent via that system will not be acknowledged.)

Office hours: TBD during the first week of class. Beginning and end times of office hours will be enforced strictly. There is no open door policy.

## Description

Three one-hour lectures discussing the basis for light water reactor (LWR) design; the NRC design criteria for LWRs. Study of the major systems, components and performance characteristics of LWRs including fuels, primary and secondary coolant systems, emergency and auxiliary systems.

## Prerequisites

EML 3100 and ENU 4605 and ENU 4001 with minimum grades of C.

## Course Objectives

Following successful completion of this course, the student will have developed an understanding of the domestic nuclear power industry, including:

- Understand the current status of the nuclear power industry and the evolving worldwide nuclear industry;
- Understand how the General Design Criteria (GDC) and Quality Assurance Criteria (QAC) affect nuclear power plant design, construction and operation;
- Be able to describe the nuclear power plant licensing process and the Nuclear Regulatory Commission (NRC) organizational structure and functions.
- Understand and be able to discuss the codes and standards applicable in the design, construction, licensing and operation of a nuclear power plant.
- Understand and be able to describe and compare in detail the reactor core, reactor coolant system, and auxiliary systems including engineered safeguards as well as reactor control, protection and instrumentation systems for typical PWR and BWR nuclear power plants.
- Understand and be able to discuss and compare the relative merits of PWRs and BWRs including comparisons with projected new plants where applicable.

## ABET Professional Component

3 credits Engineering Topics

### Student Outcomes Supported by Course

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (medium coverage)
2. n/a
3. an ability to communicate effectively with a range of audiences (medium coverage)
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 (high coverage)
5. n/a
6. n/a
7. n/a

**Text – none**

### Course Outline and Schedule

There are 20 Modules for the course.

1. Introduction to the LWR
2. US Government Relation to Nuclear Power (AEC, DOE, NRC)
3. Code of Federal Regulations
4. Other Nuclear Regulations
5. Licensing and Renewal for Nuclear Power Plants in the United States
6. Pressurized Water Reactor – Core
7. Pressurized Water Reactor – Primary Circuit
8. Pressurized Water Reactor – Secondary Circuit and Auxiliary Systems
9. Pressurized Water Reactor – Instrumentation and Controls
10. Accidents in the PWR (Focus on Three Mile Island II)
11. Boiling Water Reactor – Core
12. Boiling Water Reactor – Primary Circuit
13. Boiling Water Reactor – Auxiliary Systems
14. Boiling Water Reactor – Instrumentation and Controls
15. Accidents in the BWR (Focus on Fukushima)
16. Light Water Reactor Containment
17. Spent Fuel Systems at Nuclear Power Plants
18. The Future of the PWR (AP 1000 and EPR)
19. The Future of the BWR (ESBWR)
20. The Future of the LWR (Small Modular Reactors)

The day-by-day outline of lecture coverage is to be taken as a draft. HW deadlines will not be moved earlier, but may be moved later. Exam dates will not change, barring university closure or significant coverage delays. In the event of major coverage delays, modules 18 and 19 may be shortened and module 20 discarded.

Week	Day	Date	Due	Material
1	T	7 Jan		Syllabus, Course Policies, Introduction to the LWR
1	R	9 Jan		US Government Relation to Nuclear Power
2	T	14 Jan		US Government Relation to Nuclear Power
2	R	16 Jan	HW 1	Code of Federal Regulations
3	T	21 Jan		Other Nuclear Regulations
3	R	23 Jan	HW 2	Licensing and Renewal for NPPs in the United States
4	T	28 Jan		Pressurized Water Reactor – Core
4	R	30 Jan	HW 3	Pressurized Water Reactor – Core & Pressurized Water Reactor – Primary Circuit
5	T	4 Feb		Pressurized Water Reactor – Primary Circuit
5	R	6 Feb	Exam 1	Exam 1
6	T	11 Feb		PWR – Secondary Circuit and Auxiliary Systems
6	R	13 Feb	HW 4	Pressurized Water Reactor – Instrumentation and Controls
7	T	18 Feb		Accidents in the PWR
7	R	20 Feb	HW 5	Accidents in the PWR
8	T	25 Feb		Boiling Water Reactor – Core
8	R	27 Feb	Exam 2	Exam 2
9				No Class - Spring Break
10	T	10 Mar		Boiling Water Reactor – Primary Circuit
10	R	12 Mar	HW 6	Boiling Water Reactor – Primary Circuit & Boiling Water Reactor – Auxiliary Systems
11	T	17 Mar		Boiling Water Reactor – Auxiliary Systems Boiling Water Reactor – Instrumentation and Controls
11	R	19 Mar	HW 7	Boiling Water Reactor – Instrumentation and Controls
12	T	24 Mar		Accidents in the BWR (Focus on Fukushima)
12	R	26 Mar	HW 8	Accidents in the BWR (Focus on Fukushima)
13	T	31 Mar		Light Water Reactor Containment
13	R	2 Apr	Exam 3	Exam 3
14	T	7 Apr		Spent Fuel Systems at Nuclear Power Plants
14	R	9 Apr	HW 9	Light Water Reactor Containment
15	T	14 Apr		The Future of the PWR (AP 1000 and EPR)
15	R	16 Apr	HW 10	The Future of the BWR (ESBWR)
16	T	21 Apr		The Future of the LWR (Small Modular Reactors)
17	R	30 Apr	Exam 4	Exam 4

## Grading

There are 800 total, equally-valuable points in the course.

- Exam 1 – 150 points (Modules 1-5)
- Exam 2 – 150 points (Modules 6-10)
- Exam 3 – 150 points (Modules 11-15)
- Exam 4 – 150 points (Modules 16-20)
- HW – 200 points (10 HW, 20 points each)

The final grades will be assigned based on:

- A: 87%+
- A-: 85-86.99%
- B+: 83-84.99%
- B: 75-82.99%
- C: 67-74.99%
- E: < 67%

I reserve the right to grant higher grades at the end of the course at my sole discretion, including the use of B-, and C+. Under no circumstances will grades of C- or any flavor of D be used.

Please note the following:

1. I reserve the right to grant higher grades at the end of the course at my sole discretion, including the use of B- and C+. Under no circumstances will grades of C- or any flavor of D be used.
2. Each exam is individually curved. The details of this curve are included as part of the Exam Previews.
3. No single item exceeds 20% of your course grade. This emphasizes consistent performance in this course and limits the deleterious effect on your grade of a single poor exam.
4. Grading in this course is plus-based. That is, I award you points based on correct steps, rather than deducting points for errors. As a result, a question such as, “Dr. Schubring, why did you take off 2 points here?” is both presumptuous and nonsensical, since you never had the points.
5. 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.
6. 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 operate. This is not to grant inflated letter grades but rather to account for the inherently challenging nature of two-phase flow and to appropriately award genuinely excellent performances.
7. The gradebook on Canvas is used to enable you to look up grades quickly. Note that this gradebook is *not* official. I reserve the right to correct errors, including transcription errors, from the official (spreadsheet) gradebook, to which I alone have access, until finalization of grades with the registrar.
8. Under no circumstances will a homework be accepted after solutions have been released. If you have any form of excuse/accommodation that delays your due date until after the release

of solutions, that will be taken as an excused homework for you. The weighting of your other homework will then be increased to ensure homework is 25% of your grade.

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

## Grade Appeal

All appeals of grades, including those from clerical/grade-calculation errors, must be made within 1 week of return. (This may be modified for specific assignments. I will announce this via e-mail if 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 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.

Denied appeals may be deemed “frivolous”, if I believe the student is not acting in a good faith belief that more points are deserved. 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.

## Attendance & Class Conduct

*Skip at your peril.* Attendance is not considered in the grade. Pursuant to HWCOE policy, the following statement is required: Excused absences are consistent with university policies in the undergraduate catalog

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>  
and require appropriate documentation.

However, some materials in the course will not be covered in the textbook or in the notes provided online – only in class. Some example problems and complex figures (hard to digitize, easy to make on chalkboard) fall into this category. Students are responsible for these materials.

If a student arrives late or leaves early, he/she is expected to do so with minimum level of disruption to the class in progress. 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*. The same principle applies to office hours or appointments – if you stop by my office and your phone rings, you will be told to leave the room for the duration of that day’s office hours (or your appointment considered over).

I reserve the right to take attendance to prioritize e-mail assistance.

## Make-Up Work Policies

Late-work excuses (extensions) 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. Most requests are granted, excluding those that provide a student or group of students an unfair advantage, 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 issues 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 generally limited to those mandated by the letter of UF policies. The list of UF-approved personal reasons changes from time to time. 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.

I reserve the right to grant extensions for other personal reasons as *rare exceptions to the rule* at my sole discretion – advance notice gives you the best chance at a favorable decision. The approval of an extension does not establish precedent for that student (notably, there are some scenarios that I may accommodate only once) or for other students with similar circumstances.

The 12-day rule will be enforced strictly. Note that the count of days is based on a per-student, not per-approved-activity basis.

For the purposes of this course, in the above-referenced list of approved absence (extension) reasons, the word “family” shall be taken to mean your parents, grandparents, great-grandparents (etc.); children, grandchildren (etc.); siblings; aunts/uncles; nieces/nephews; your spouse and the spouse of any of the above; and half- or step- “versions” of the above categories. More distant relatives (a cousin, your spouse’s sibling’s spouse, etc.), partners (excluding spouses), and pets are not included. Minor illnesses (guideline: anything meriting home care only or care at a walk-in clinic, as opposed to an ER) of family members, including minor children, do not count as serious family emergencies, nor do events such as birthdays, anniversaries, weddings, etc.

Political activities, including protests, demonstrations, and the like are considered personal matters and not generally permitted as reasons for extensions. This includes activities related to nuclear engineering or nuclear power. Exceptions: (1) A student who is pursuing nuclear-related (whether pro- or anti-) politics as a career path may be granted extensions, at my discretion, on condition of providing evidence of *bona fide* efforts to secure a full-time position or to secure admission to a relevant, non-STEM degree-granting graduate program and (2) activities between November 26 and November 28, inclusive, that are connected to the 2019 ANS Student Conference will be taken as related to that professional activity and potentially grounds for extensions.

Further, be advised that any approved reasons for extensions do not reduce the amount of work you are expected to complete, but merely rearranges the timing. For those issues that are predictable (interview, holidays, etc.), you should work ahead to avoid disruption.

## Homework

*Excluding the make-up work policies, above, no late homework will be accepted.*

Homework may be submitted electronically (via Canvas) or as hard copy; some may have required electronic submissions indicated on the assignment sheets. The following restrictions apply for electronic submissions:

- Submissions may include multiple files, but only files with the following extensions will be accepted: pdf, xls, xlsx, and .txt.
- If a hard copy and electronic submission are provided, the hard copy will take precedence. (Only it will be read, reviewed, and graded.) You may not submit parts of the homework electronically and parts in hard copy, unless explicitly allowed on that assignment sheet.

## Examinations

For each exam, you will receive an Exam Preview, intended to prepare you for taking the exam (both technically and procedurally). Detailed policies (including grading/curving) are included on this document. The preview will also include the specific topics addressed by the problem (for most problems), the way points are distributed among problems, and a brief list of topics within the scope of the exam.

Examinations are due at the end of the examination period. No collaboration is permitted during examinations, although you may prepare for these however you choose. Use of any unauthorized materials or any communication (including mobile phones, laptops, or face-to-face with classmates in the room) is grounds for *immediate and final* collection of your exam with no more work permitted and any work already completed that, in my judgement, was aided by said materials/communication not considered in grading. Examinations consist of two stages: a closed-note/book conceptual and open-note/book problem solving.

The criteria for make-up exams are the same as for extensions to other assignments. All make-up exams will be held after the regular exam, as organized with me. Note that conflicts in my proposed make-up times with your personal business will not, in general, be accommodated.

UF policy restricts make-up finals to Friday, May 1, 1500-1700, barring a conflict at that time with another make-up in a course of higher number. This rule applies regardless of your personal business, such as travel times. I strongly discourage you from making hard-to-change travel plans such as flight reservations before Friday evening.

In the unlikely event you (1) are unable to complete the exam at the time originally scheduled for allowed reasons, (2) are unable to make the UF-appointed make-up exam time for allowed reasons, (3) do not make-up the exam at some other time prior to the finalization of grades on May 6, and (4) are on pace to pass the course, you will receive a grade of I (Incomplete). In the (also unlikely) case that the first three of these conditions apply but you were on pace to fail the course, UF policy requires that I assign a failing grade with the notation that you stopped participating before the end of the term. This may have implications on financial aid beyond a simple “E” grade.

## Other Course Policies

### Electronic Communication

The primary means of communication with the class outside of class time will be e-mail listserv. These listservs will send to your @ufl.edu address only. Any inquiries regarding grading will be directed towards your @ufl.edu address only, per FERPA.

Technical and procedural questions will be answered as a reply to whatever e-mail address you used to send them. If the entire class will benefit from the answer, I may send to the class list (either in lieu of or in addition to a direct reply to you, at my discretion). If you do not wish to have a specific e-mail to me regarding technical content or course procedures replied to through the class list, you must explicitly state this in that e-mail. In such a case, I will reply directly to you and send a general-purpose announcement to the class list, not indicating who caused me to send it.

When sending questions via e-mail, please make sure you provide all the information needed for me to produce an answer or solution. This includes any files on which you are working. (Note: I will not open files from students in the following formats: .ppt, .pptx, .doc, .docx; make a PDF and send that if needed.)

The primary use of the Canvas website is for file storage, as all assignments, lecture notes, etc. will be provided there. I take no responsibility for downtime of this service, nor for actions of University of Florida staff that affect the website (including Canvas upgrades).

### Letters of Recommendation/Evaluation Policy

To request a letter of recommendation/evaluation (for graduate school or otherwise), you must provide:

- A hard copy of your UF transcript.
- A hard copy of a résumé (or CV).
- A hard copy of the following form: <http://www.registrar.ufl.edu/pdf/ferparelease.pdf>. You *must* check all four circles.

Letters are typically filed once per week. For students whom I know only through coursework, my letter typically focuses on an estimate of their rank-in-class and on their performance on projects (from other courses) and challenging problems.

I will only file *one batch* of letters per student during the term, for any student currently enrolled in a class with me. (This policy is designed to keep me from looking up slight changes in your rank/performance multiple times for multiple batches of letters.) I recommend that this batch occur as late as possible in the term to allow me sufficient information (sample size) on your performance to write a useful letter.

I reserve the right to refuse provide a letter for any student and am not obligated to provide a reason for such refusal.

## Syllabus Boilerplate

### Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to me when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

### Course Evaluations

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>.

Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>.

Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>

### University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code:

<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>

specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

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

- Your academic advisor or Undergraduate/Graduate Program Coordinator [for NE/NES students, these are both also your instructor]
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)

- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@ufl.edu](mailto:nishida@ufl.edu)

## Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

## Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see:

<http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

## Campus Resources

### Health and Wellness

U Matter, We Care: If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center (392-1575) and

<http://www.counseling.ufl.edu/cwc>

University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>

### Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu)

<https://lss.at.ufl.edu/help.shtml>

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling.

<https://www.crc.ufl.edu/>

Library Support, Various ways to receive assistance with respect to using the libraries or finding resources.

<http://cms.uflib.ufl.edu/ask>

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.

<https://teachingcenter.ufl.edu/>

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.

<https://writing.ufl.edu/writing-studio/>

Student Complaints Campus:

[https://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf)

On-Line Students Complaints:

<http://www.distance.ufl.edu/student-complaint-process>