

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

## **1. Description**

Advanced light-water reactors, gas-cooled reactors, liquid-metal reactors. Thermal modeling, reactor safety, licensing, reactor physics, materials selection, and fuel cycles.

## **2. Pre-requisites**

(ENU 4134 or ENU 6135) and (ENU 4103 or ENU 6106)

## **3. Course Objectives**

1. Provide students with an understanding of advances in light-water reactor (LWR) technology seen in Generation III (Year 2000 and beyond) systems and the ability to discuss and analyze the improvements to reactor safety in these systems
2. Provide students with an understanding of relevant phenomena (thermal, material, neutronic) for novel reactor systems (gas-cooled reactors, liquid-metal reactors, etc.) to make relevant comparisons both among these novel concepts and with existing LWR systems
3. Prepare students to undertake research in the areas of advanced nuclear fission reactor design

## **4. Contribution of Course to Meeting the Professional Component**

n/a, graduate course

## **5. Relationship of course to program outcomes**

n/a, graduate course

## **6. Instructor**

DuWayne Schubring, Assistant Professor

205 Nuclear Science Building

352-392-1401 x314

[dlschubring@ufl.edu](mailto:dlschubring@ufl.edu)

Office hours: MWF 1230-1330, via e-mail, or appointment.

Course website: ELearning/Sakai platform.

## **7. Teaching Assistant**

None

## **8/9/10 Course Meetings**

MWF, 1355-1445 (UF “Period” 7), NSC 225. **No final exam.**

## 11. Material and Supply Fees

None

## 12. Text (Required)

None. Notes to be provided.

## 13. References

*Nuclear Systems I: Thermal Hydraulic Fundamentals*, N.E. Todreas and M.S. Kazimi, 2011 (2nd edition). (ISBN: 9781439808870)

*Nuclear Heat Transport*, M. M. El-Wakil, 1978 (1st edition). (ISBN: 0894480146).

*Nuclear Energy Conversion*, M. M. El-Wakil, 1982 (Revised Edition). (ISBN: 0894480154).

*Nuclear Reactor Analysis*, J. J. Duderstadt and L. J. Hamilton, 1976. (ISBN: 0471223638).

References from recent literature will be provided electronically.

## 14. Course Outline (Schedule)

- Water-cooled Reactors
  - Generation III/III+ PWRs (emphasis on AP1000, secondary emphasis on EPR), focusing on improvements in safety relative to Generation II systems and including construction experience
  - Generation III/III+ BWRs (emphasis on ESBWR), focusing on improvements in safety relative to Generation II systems and including construction experience
  - Heavy water reactors (emphasis on CANDU series)
  - Supercritical water reactors, including thermal-, mixed-, and fast-spectrum designs
- Gas-cooled thermal-spectrum reactors
  - Materials selection and development, with an emphasis on TRISO fuel
  - Core layout and nuclear analysis (reactor physics)
  - Thermal analysis, including in-core calculations and balance-of-plant (power cycles)
- Fast-spectrum reactors (emphasis on sodium-cooled reactor)
  - Materials selection and development, focusing on fuel forms and cladding materials
  - Core layout and nuclear analysis (reactor physics), including burnup and breeding considerations
  - Thermal analysis, including in-core calculations and balance-of-plant (power cycles)
  - Comparison among coolant options (sodium, lead, LBE, NaK, gas, etc.)

There will be 3-4 projects per main topic. These projects are of intermediate length, complexity, and open-ended-ness between ENU 4134/6135 HW and Projects. Some projects may require access to export-controlled software. Appropriate accommodations, which may include restrictions on your choice of which project(s) to drop, will be made.

You must complete 9 of these 10-12 (almost certainly 10 or 11) projects. (You may not do all and drop the lowest.) Your 10<sup>th</sup> project will be a written report evaluating the relative merits of the reactors discussed. This project will be due at the final class period and cannot be skipped.

## 15. Attendance and Expectations

### Attendance & Class Conduct

*Skip at your peril.* 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. 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).

The instructor reserves the right to take attendance to prioritize e-mail assistance.

### Projects

Electronic submission of project narratives is not accepted. Electronic submission of files used on projects (spreadsheets, etc.) may be required for some projects, as indicated on the assignment sheet. Submissions *must* be in the formats requested. If you do not know how to convert your files to these formats, contact the instructor in advance of the deadline. Not knowing your software is not an excuse for late projects!

The allowable level of collaboration on projects may vary throughout the course and is indicated clearly on each assignment. On group projects, you will need to collaborate with and divide labor among the members of your team, but no collaboration among teams is permitted. Projects handed in between the due date and the next scheduled class period are worth 75% credit. Submissions after that are not accepted (0 credit). If your project is late, the onus is on you to provide it to me; *the clock does not stop until I have the project in hand.*

Certain professional document and figure standards will be enforced on project narratives; *the onus is on you to figure out how to meet these standards in whatever programs you use to write the document and make figures.* Your instructor has little sympathy for those who select a word processor without knowing how to format their text using it – complaints that the standards are not the same as a particular piece of software's defaults will fall on deaf ears.

### Make-Up Work Policies

Absences and 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 instructor's 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), the instructor 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.* UF-authorized extensions include UAA competitions, religious observances, and serious illness or death of specified relatives. There is no single document listing all UF-approved personal reasons for absence/extension; further, the list of 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 policies, contact the instructor in advance.

## File Formats

The electronic components of project submissions *must* be in the formats requested. If you do not know how to convert your files to these formats, contact the instructor in advance of the deadline. Not knowing your software is not an excuse for late projects. Acceptable formats may include plain text, .pdf, .csv, .xls, .xlsx, and EES files, as well as other file formats at the instructor's discretion.

In particular, the instructor will not open files from students in the following formats: .ppt, .pptx, .doc, .docx. Presentation and word processing documents are best converted to .pdf. Spreadsheets can be converted to .xls or .csv.

## E-mail

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 compliance regulations.

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.

## 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 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.)

### Grade Appeal

All appeals of grades, including those from clerical/grade-calculation errors, must be made within one week of return. The date of return is the date on which the projects are returned in class (that is, if you skip class, you do not get more time to appeal). As the term concludes, the length of this appeal period may be reduced to comply with the deadline for submission of grades. You will be advised via e-mail as to shortened appeal timeframes.

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 20% with Part 2 worth 50%.

Denied appeals may be deemed “frivolous”, if the instructor believes 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.

### 16/17. Grading

Your course grade is based on the average of your project grades. There is no final.

Components of the projects with exactly one correct solution will be graded between 0 and 4; open-ended components (writing, professionalism, design, optimization, analysis, etc.) will be graded to a maximum of 5. As a result, grades above 4.0 will be awarded for genuinely exceptional work. Project grades of 1.75 and above can be roughly interpreted on the GPA scale.

- A: 3.6 +
- A-: 3.5-3.59
- B+: 3.4-3.49
- B: 2.5-3.39
- C: 1.75-2.49
- E: 0-1.74

The instructor reserves the right to round individual project grades to the nearest 0.1 and to grant grades more generous than this scale at discretion at the end of the course, including B- or C+. *Under no circumstances will grades of C- or any flavor of D be used.*

COE required statement: “Graduate students need an overall GPA of 3.00 truncated and a 3.00 truncated GPA in their major (and in the minor, if a minor is declared) at graduation. For more information on grades and grading policies, please visit:

<http://gradcatalog.ufl.edu/content.php?catoid=4&navoid=907#grades>

## **18. Make-up Exams**

No exams means no make-up exam. Policies regarding projects are detailed in Item 15.

## **19. 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:

<http://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.

Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures. See:

<http://www.dso.ufl.edu/sccr/procedures/honorcode.php>

## **20. Accommodation for Students with Disabilities**

Students requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

## **21. UF Counseling Services**

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575,  
<http://www.counseling.ufl.edu/cwc/Default.aspx>  
Counseling services and mental health services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.
- University Police Department 392-1111

## **22. Software Use:**

All faculty, staff and student 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.

## **23. Course Evaluations**

The University of Florida expects students to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online at

<https://evaluations.ufl.edu>

Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at

<https://evaluations.ufl.edu/results>