

Updates/changes to this syllabus, and all other course information, provided via ELearning (system TBD).

## 1. Description

Topics in nuclear thermal hydraulics, fluid mechanics, and heat transfer beyond required undergraduate coursework including areas of ongoing research and applications to current and future nuclear fission reactors.

## 2. Pre-requisites

Required skills: grasp of fluid mechanics and heat transfer at the undergraduate level, plus one additional course in (1) nuclear thermal hydraulics, (2) graduate-level fluid mechanics, or (3) graduate-level (convective) heat transfer.

UF course numbers: ENU 4134 or ENU 6135 or EGM 6812 or EML 6155.

## 3. Course Objectives

1. Provide students who have previous nuclear engineering background with a conceptual and analytical understanding of major thermal hydraulic considerations, beyond those discussed in the required undergraduate NE curriculum, that they are likely to encounter in a reactor engineering career
2. Provide students who have previous thermal sciences background with a conceptual and analytical understanding of major thermal issues in nuclear power facilities (both existing and proposed) to allow them to transfer their broader thermal sciences skills to a reactor engineering career
3. Prepare students to undertake research in the areas of nuclear thermal hydraulics currently under active investigation

## 4. Instructor

DuWayne Schubring, Assistant Professor  
205 Nuclear Science Building  
352-392-1401 x314  
dlschubring@ufl.edu  
Office hours: MF 1500-1600 (tentative) and by appointment

## 5. Teaching Assistant

None

## 6/7/8. Course Meetings

MWF 1:55-2:45 pm (UF “Period” 7).

The assigned final exam period begins at 1500 on April 30. The final deadline of projects (minimum 1, maximum 4) will be set to this time – turn-in to my mailbox – to be considered as a “take-home” final.

## 9. Material and Supply Fees

None

## 10. Text (Required)

None. Notes to be provided.

## 11. References

*Nuclear Systems I: Thermal Hydraulic Fundamentals*, N.E. Todreas and M.S. Kazimi, 1990 (1st edition). (ISBN: 1560320516)

*Nuclear Heat Transport*, M. M. El-Wakil, 1978 (1st edition). (ISBN: 0894480146). A second book on nuclear-specific thermal issues.

Any undergraduate textbooks (typically aimed at mechanical engineering students) on thermodynamics, fluid dynamics, and heat transfer.

## 12. Course Outline (Schedule)

The following 9 topics are considered the core material for the class. These will be covered first.

- Bubbly/Slug Flow – Interfacial Area Transport Equation
- Annular Flow – Films and Droplets
- Experimental/Visualization Techniques
- Supercritical Flow and Heat Transfer
- Liquid Metal Heat Transfer
- Packed (Pebble) Bed Flow and Heat Transfer
- Natural Circulation in Nuclear Systems
- Thermal Hydraulics and Neutronics Coupling
- Advanced Power Cycles for Nuclear Applications

Selected topics from the following list may also be covered, subject to time constraints. Student feedback on the priority list will be solicited later in the term.

- Introduction to Computational Fluid Dynamics
- Turbulence Modeling for Nuclear Applications
- Severe Accident Thermal Hydraulics
- Integral System Experiments
- Additional topics TBD (including student suggestions)

Each topic is covered in a “Module” that will each have a short project attached, typically due during the following module.

You may skip up to 2 projects. (You may not do them all and drop the lowest two.) If 12 or more topics are covered, you will be permitted a 3rd skip.

The TH/neutronics coupling project may require access to MCNP. If you are unable to get access to this code, which is export-controlled, this will be among your dropped projects.

An additional project (termed Project 0) is a review of a paper on nuclear thermal hydraulics, to be presented to the class. This project may not be skipped. Detailed literature review instructions will be provided in a separate document.

### 13. Attendance and Expectations

#### Attendance & Class Conduct

*Skip at your peril.* Attendance is not considered in the grade. However, some materials in the course will not be covered in the references 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 presentation 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).

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 will vary throughout the course and is indicated 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. Late projects will lose 10% of their value each *calendar* day, rounded up (so 3 hours late is considered 1 day late). Any project strictly more than 3 calendar days late will have no value. If your project is late, the onus is on you to provide it to me; *the clock does not stop until I have a hard copy of your 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 program(s) 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.

## 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.
- The instructor 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 A was worth only 20% with Part B worth 80%. Repeated frivolous appeals may lead to revocation of grade appeal privilege on an individual basis.

## 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 work. Acceptable formats may include plain text, .pdf, .csv, 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.

The instructor will open spreadsheets in .csv, .xls, or .xlsx format. Please be aware that .xlsx format has remaining compatibility issues with free office software; .xls is usually a wiser choice.

### **E-mail**

The primary means of communication with the class outside of class time will be e-mail listserv. 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.

### **14/15. Grading**

Your course grade is based on the average of your project grades, excluding skips. Project grades of 1.75 and above can be roughly interpreted on the GPA scale. Grades above 4.0 may be awarded for genuinely exceptional work.

- A: 3.6 +
- A-: 3.5-3.599
- B+: 3.4-3.499
- B: 2.5-3.399
- C: 1.75-2.499
- E: 0-1.749

The instructor reserves the right to grant grades more generous than this scale at discretion at the end of the course. *Under no circumstances will grades of C- or any flavor of D be used.*

The following statement is required by COE policy: “In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B-average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit

<http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades>”

### **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.)

## 16. Make-up Exam Policy

n/a, no exams

## 17. Honesty Policy

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

*Addendum to 19:* Violations of UF Academic Honesty policies in this course will be reported through appropriate channels. If you choose to commit academic misconduct in this course, expect to receive a failing grade for the course.

## 18. 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.

## 19. 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, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

## 20. 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.

## **21. 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>