

Advanced Nuclear Thermal Hydraulics  
ENU 6136, Section 149H, Spring 2017  
MWF 1355-1445, UF “Period” 7  
MAEB 229  
Final Exam: None

### **Instructor**

DuWayne Schubring, Assistant Professor  
205 Nuclear Sciences Building  
352-392-0852  
dlschubring@ufl.edu  
Office hours: MWF 1230-1330, MF 1500-1600, by e-mail, and appointment.

### **Course 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.

### **Prerequisites**

ENU 4134 or ENU 6135 or EGM 6812 or EML 6155

### **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

### **Textbook**

None

### **Reference Materials**

*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.

## Course Schedule

We will plan to cover the following topics at a rate of approximately 1 per week

1. Introduction to Turbulence; Turbulence Modeling
2. Experimental/Visualization Techniques
3. Flow Regimes in Two-Phase Flow (Introduction)
4. Interfacial Area Transport Equation (Bubbly Flow)
5. Annular Flow – Traditional Models
6. Annular Flow – Modern Models
7. Natural Circulation in Nuclear Systems
8. Supercritical Flow and Heat Transfer
9. Liquid Metal Heat Transfer
10. Packed (Pebble) Bed Flow and Heat Transfer
11. Thermal Hydraulics and Neutronics Coupling
12. Advanced Power Cycles for Nuclear Applications
13. Severe Accident Thermal Hydraulics

Each topic will have an attached homework assignment. In addition, HW 0 is a review of a paper on nuclear thermal hydraulics, to be presented to the class in the final week. Detailed literature review instructions will be provided in a separate document. In the event that not all topics can be covered fully, the instructor reserves the right to determine which topics will be done in abbreviated form (lectures only, no HW) or skipped entirely. See also the grading section for how this would affect the coursework.

The homework on “Thermal Hydraulics and Neutronics Coupling” may require access to MCNP. If you do not have access to this code, that will be one of your three allowed skips (see the grading section).

## Attendance Policy, Class Expectations, and Make-Up Policy

### Attendance and 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).

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

## Late 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.

*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.* 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 policies, contact me in advance.

All requests for extension must be submitted in writing, preferably via e-mail.

Pursuant to HWCOE policy, the following statement is required: Excused absences are consistent with university policies in the graduate catalog

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>  
and require appropriate documentation.

For unexcused late work, a 25% deduction will be applied to any homework turned in one class period late. No homework will be accepted after this. Any homework due the last day of class must be turned in on time, else will have no credit. If your homework 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.*

For the purposes of this course, in the above-referenced list of approved absence 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 (cousins, 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.

## 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 20% Part 2 worth 50%.

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.

### **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 me in advance of the deadline. Not knowing your software is not an excuse for late work! Accepted formats may include plain text, .pdf, .csv, and EES files, as well as other file formats at my discretion. I will not open files from students in the following formats: .ppt, .pptx, .doc, .docx. Presentation and word processing documents are best converted to .pdf. I will open spreadsheets in .csv, .xls, or .xlsx format.

### **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.

### **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.) 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 to provide a letter for any student and am not obligated to provide a reason for such refusal.

## Evaluation of Grades

Your grade is entirely based on the average of your homework scores, which are tabulated as scores out of 10. There are 14 homework assignments in the course (HW 0 – the literature review – plus HW 1-13 – one for each topic).

You must complete 11 of these assignments, including HW 0. You may not do more than 12 assignments and drop the lowest.

In the event that we do not get through all topics, the number of homework assignments will be reduced, but your number of allowed skips will not. For example, if we complete only 11 out of 13 topics, there will be 12 assignments from which you must complete 9.

- A: > 86%
- A-: 84-85.99%
- B+: 82-83.99%
- B: 75-81.99%
- C: 67-74.99%
- E: < 67%

I reserve the right to grant grades more generous than this scale at discretion at the end of the course, including + and - minus grades. *Under no circumstances will grades of C- or any flavor of D be used.*

Canvas is used to enable you to look up grades quickly. Note that the Canvas 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.

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

## 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.

No retroactive accommodations are available, per UF policy.

## Course Evaluations

UF expects students to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. 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/>.

## 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.

## 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>

## 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.