

Advanced Nuclear Thermal Hydraulics
ENU 6136, Section 26076, Spring 2020
Room and Time TBD
Final Exam: None

Instructor

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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.

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 13 topics in the first 13-14 weeks:

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. These presentations will take place in Weeks 14 and 15.

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).

Grading

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: 87%+
- A-: 85-86.99%

- B+: 83-84.99%
- B: 75-82.99%
- C: 66-74.99%
- E: < 66%

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:

<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 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 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.

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.

Course-Specific Policies

Attendance

Skip at your peril. Attendance is not considered in the grade. However, I reserve the right to take attendance to prioritize e-mail assistance. 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.

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.

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 15 and November 22, inclusive, that are connected to the 2019 ANS “Winter” Meeting 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.

Class Conduct

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). Students who arrive late, leave early, or step out briefly mid-class to handle personal business must do so with a minimum level of disruption to the class in progress.

Rare exceptions to the above may be offered with notice (including just before class) and meritorious reasons (*e.g.*; an in-progress surgery of a close family member).

While I am generally available to students for a few minutes after class, there may be some Wednesdays where this is not the case. If so, I will announce this at the beginning of class and/or just prior to the mid-class break. In this case, any needed brief discussions can occur during the mid-class break.

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, ods, numbers, ees, 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 assignment electronically and parts in hard copy, unless explicitly allowed on that assignment sheet.

For handwritten homework, use pencil or black/dark-blue ink and either white paper (lined or not) or engineering paper. If you choose the combination of pencil and (yellow) engineering paper, write largely/clearly enough to be easily readable. Homework on other paper or with other writing instruments will be accepted, but you will earn no credit for homework that is not readable.

The onus is on the student to submit the solutions in the documents or files presented. No credit will be granted if the wrong document is handed in or the wrong file uploaded. In the case of EES files, the instructor will only use Solve, Min/Max, and Evaluate Parametric Table functions. You may not have a single file to solve multiple problems with instructions for all but one problem commented out & provide the instructor a list of instructions to complete a scavenger hunt for the remaining problems.

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, particularly EES 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.)

Course Website (Canvas)

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).

Recording Lectures, etc.

UF grants each student the right to record classes for which they enroll, on the condition that no disruptions are presented to other students or faculty. You are not required to inform me that you are recording these class sessions. Failures of your recording equipment are *not my problem* – requests to delay the meeting or to repeat myself for the convenience of your recording will not be honored.

Further, you are permitted to record office hour or appointment conversation on ENU 4134 questions. If you wish to record office hours or appointments, you must inform (not ask) me that you will be recording. In this case, our conversation will be restricted to the content of this course. If you wish to ask more general questions, such as those relating to academic planning or your future career goals, I will insist that you turn the recording off before I discuss those subjects.

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 with all four circles checked (requests with three or fewer circles checked will be denied):

<http://www.registrar.ufl.edu/pdf/ferparelease.pdf>.

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.

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.

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
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, 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:

<https://registrar.ufl.edu/ferpa.html>

Campus Resources

Health and Wellness

U Matter, We Care

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center:

<http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

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

<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

On-Line Students Complaints:

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