

NRE 4214 – Reactor Engineering (Fall 2026)

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Office Location: Boggs 3-85

Office Hours: T/Th 1:30 – 3:30 or by appointment (always best)

I am happy to meet in-person, over the phone, or via Teams or some other platform

Course Description

This course covers the design characteristics of nuclear reactors and the principles of nuclear energy conversion to electric power. The content of the course includes: fundamentals of energy conversion; design and characteristics of light water reactors with emphasis on boiling water and pressurized water reactors; thermodynamic aspects of LWRs, gas cooled reactors, and fast breeder reactors; thermal analysis; safety elements and accident prevention systems; pressure drop across cores and driving pressure; single & two-phase flow analysis; and critical heat flux. Time permitting, we will review novel reactor concept designs including those that have been built and operated as well as those falling into the category of Generation IV reactors. Examples include aqueous reactors, pebble bed reactors, salt-fueled reactors, SMRs, micro-reactors, etc.

Prerequisites

ME 3340 – Fluid Mechanics

ME 3345 – Heat Transfer

Course Details

Term: Fall 2026

Course name: Reactor Engineering

CRN: 87334

Course number: NRE 4214

Section number: B

Meeting times: Monday/Wednesday 12:30 pm – 1:45 pm

Room building & number: Boggs 328

Learning Objectives

Upon successful completion of this course, students should be able to:

1. Understand design characteristics of nuclear reactor systems
2. Apply thermodynamic principles to reactor design and operations
3. Compute pressure drops in channels and associated driving pressures
4. Solve the heat conduction equation for various fuel element geometries
5. Solve single and two-phase fluid transport problems under limiting conditions
6. Understand critical heat flux and departure from nucleate boiling

Textbook

N. Todreas and M. Kazimi, Nuclear Systems I: Thermal Hydraulic Fundamentals, 3rd Edition, Taylor & Francis, 2021

Additional Materials/Resources

M. M. El-Wakil, Nuclear Energy Conversion, American Nuclear Society, 1992.

Other books, reviews, and papers indicated in lecture notes and/or posted on Canvas. NOTE: Most lectures use outside sources in addition to (or instead of) the textbook. Canvas will be used as the course website to communicate with the students.

Grading

Exams (2): 40%

Final Exam: 20%

HW & Quizzes: 25%

Projects (2) 15%

Grade Scale: A: (90-100), B: (80-89), C: (70-79), D: (60-69), F: (0-59)

Attendance Policy

Students are expected to attend all classes for their full length. If a student is unable to attend a class for whatever reason, it is the student's responsibility to acquire any missed notes, lecture materials, or other information disseminated in class. If you know in advance that you will not be able to attend a class, please let me know so that you can avoid getting a zero on an unannounced quiz (see below regarding missed quizzes).

Most lectures will be streamed on Microsoft Teams, and students who are unable to physically make it to class for whatever reason can login and participate remotely. This does NOT substitute for face-to-face attendance. Rather, this provides you the student with the benefit of (1) still taking part in class if you are unable to physically attend and (2) having a recording of the lecture so that you can review it if needed.

I do NOT DISTRIBUTE my personal notes, lecture materials, or problem solutions, so if you miss class you must get this information from another student.

Homework

Regarding late work: I realize that unforeseen events happen and situations arise. Late work can be turned in within 24 hours of the due date for a maximum grade of 50%. The assignment will not be accepted after 24 hours from the due date and will receive a zero. However, there are times when I will review the homework within this 1-day window. If this happens, then I can no longer accept the assignment, and it will automatically receive a zero. Obviously, there are exceptions at my discretion, but if something comes up that hinders you from turning in the HW on time, the earlier you let me know the better chance I can accommodate you.

Note that homework is **sometimes** graded on **effort & completeness**, rather than accuracy. Thus, it is usually in your best interest to submit an incomplete assignment on time, rather than a complete assignment late. Homework should be submitted at the start of class unless an instant arises where an electronic copy can be submitted to **Canvas** or emailed directly to the instructor in PDF format.

Quizzes

Quizzes may be given throughout the term either in-person or via **Canvas**. In-person quizzes will not be announced. If the quiz is given online, then you will have a certain time window (usually a few days) to complete the quiz. I will alert the class when a quiz has been posted, and once a quiz has been made available, I highly encourage you to take it at your earliest availability rather than wait. Note that I have **never extended** a quiz for an individual who simply forgot to take it.

The time allotted for all quizzes is short, generally about 15-20 minutes. Although the quiz will close on Canvas after the allotted time, you can still submit any work you have done for partial credit (and I highly encourage this). However, the submitted work must align with any answers you have submitted, thus you **must submit something** to Canvas in order to receive partial credit. If what you submit to Canvas does not

align with work that you submit, this amounts to cheating (see Cheating & Honor Code below). A student can always choose to come to my office and take a quiz in-person rather than online, but you must request this in a timely manner in order to ensure instructor availability.

Points awarded on Homework and Quiz assignments will sum to give the total towards the final grade

For example, if you have the following scores:

HW1: 42/45

HW2: 55/55

HW3: 0/55

Quiz1: 10/10

Quiz2: 5/10

Fraction of total points earned: $\frac{42+55+0+10+5}{45+55+55+10+10} = 0.64$

Total HW/Quiz points towards final grade: $(0.64)(30) = 19.2$

Points awarded on the exams (not including the final) will sum in a similar fashion.

Project

Project details will be given out later since the exact nature of the project(s) may vary depending on how the semester unfolds.

Tests and Final Exam

All students are expected to be present at the time exams are given. Students not present at the time when an exam is given will receive a “0” for that exam. No make-up exams will be given unless the student makes arrangements with the instructor prior to the exam date to receive an excused absence. The students will be informed when an exam will take place at least one week before the exam. The format for the tests and the final will be explained at this time.

Extra Credit

Certain homework and exams may have extra credit problems that the student can choose to perform if they wish. There will NOT be an extra credit assignment.

Cheating & Honor Code

Students are expected to abide by all policies set by the instructor regarding what is permitted and what is not permitted for all assignments. Unless explicitly stated otherwise, students must **always** abide by the following:

- Homework: students can work alone or in groups, but each student must submit only their individual work. Copying is never allowed.
- Quizzes: students must work alone. Students cannot seek outside assistance and can only ask the instructor for guidance/help.
- Tests/Final: students must work alone. Students cannot seek outside assistance and can only ask the instructor for guidance/help.

Outside assistance includes utilization of websites and other tools. If you are unsure of something, just ask. Violation of any of the above will constitute a “0” grade on the assignment as well as notification of the College Dean and Department Head.

The Honor Code can be found at: <http://www.honor.gatech.edu>

Course Outline

Week	Description	
1	Introduction & Scope; Reactor Descriptions	K&T ch.1&2
2	Thermodynamic Aspects of Reactors	Personal notes
3	Thermal Design Principles	
4,5	BWR Design Characteristics (Exam 1)	
6,7	PWR Design Characteristics	
8	Reactor Heat Generation; Core Power Distribution	
9	Thermal Analysis of Fuel Elements	
10	Fuel Management and Reload (Exam 2)	
11	Pool Boiling / Flow Boiling	
12	Single Phase Fluid Mechanics / Heat Transfer	
13	Two-Phase Flow; Boiling Heat Transfer; Post CHF Heat Transfer	
14	Brayton Cycle; Gas-Cooled Reactor Characteristics	
15	Fast Breeder Reactors / Novel Reactor Designs	
	Review	
	Final Exam: TBD See Registrar for official listing	

The above schedule is tentative, and subject to change at any time.

Additional Information

GT Policy on Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodations, contact the Office of Disability Services at (404) 894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodation letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs.

GT Policy on Excused Absences for Religious Observances

Georgia Tech policy on excused absences for religious observances: <http://www.catalog.gatech.edu/rules/4/>: “Students who are absent because of participation in a particular religious observance will be permitted to make up the work missed during their absence with no late penalty, provided the student informs the course instructor of the upcoming absence, in writing, within the first two weeks of class, and provided the student makes up the missed material within the timeframe established by the course instructor.”

GT Policy on Absences for Medical Reasons

GT policy on absences for medical reasons. <http://www.catalog.gatech.edu/rules/4/> Students will work with the Office of VP for Student Life (Dean of Students) to have them verify that the student was ill 3 and to determine the severity of the problem; the Dean’s office will then interact with the instructor(s) if necessary. To the extent possible, requests from the Office of the Dean of Students to excuse a medical emergency or illness and allow make-up of the work missed, including homework, examinations, or other class assignments will be accommodated.

Policy on Unforeseen or Emergency Situations

If due to an unfortunate unplanned emergency such as a car accident, a theft or burglary in your apartment, you are unable to attend an exam at the last minute, a police report substantiating the accident or mishap must be provided. Requests for accommodating an absence that are made after the exam will under almost all circumstances, without the above documentation, not be honored. Under the unlikely and highly discouraged event that you have to miss the final exam, alternate arrangements will be made on a case-by-case basis, including, but not limited to, a one-on-one oral exam of appropriate duration, to test your knowledge in the

subject matter.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectation that you can have of faculty and that faculty have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, we encourage you to remain committed to the ideals of Georgia Tech while in this class.

Campus Resources for Students

The CARE Center and the Counseling Center, Stamps Health Services, and the Dean of Students Office will offer both in-person and virtual appointments. Student Center services and operations are available on the Student Center website. For more information on these and other student services, contact the Dean of Students or the Division of Student Life.

Mental Health & Wellness

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, depression, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. GT offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know is experiencing any of the issues noted above, consider utilizing the confidential mental health services available on campus. I encourage you to reach out to GT CARE (www.care.gatech.edu, 404-894-3498) or the Counseling Center (www.counseling.gatech.edu, 404-894-2575) for support. An on-campus counselor or after-hours services are available to assist you.