Fall 2025

NRE 3208

Nuclear Reactor Physics I

Location	Mason 2117
Time	TR, 12:30–13:45
Instructor	Dr. Dan Kotlyar
Office Location	Virtually (Teams / Zoom); Boggs 3-73
Office Hours	TR 14:30–15:30 pm (by appointment)
E-mail	dan.kotlyar@me.gatech.edu

Course Description: This course covers the physical theory of nuclear reactors.
Prerequisites: NRE 3301 (Radiation Phys.), MATH 2403 (Differential Equations)
Credit Hours: 3

Textbook: *Introduction to Nuclear Engineering*, **Authors** J.R. Lamarsh and A.J. Baratta; 3rd edition, Prentice-Hall (2001)
Reference: *Nuclear Reactor Analysis*, **Authors** J. Duderstadt and L.J. Hamilton; Wiley (1976)
Reference: *Nuclear Reactor Physics*, **Author** W.M. Stacey; Wiley (2007)

Course Objectives:
At the completion of this course, students will be able to:

1. Understand the technical topics that constitute the discipline of reactor physics.
2. Explain the relationships among variables underlying the theory of nuclear fission reactors using mathematical models and their associated physical behaviors.
3. Solve static reactor physics problems in one-speed and 2-group diffusion theory.
4. Solve time-dependent diffusion theory.
5. Understand the relationship between basic Reactor Physcics concepts and actual reactor characteristics.
6. Comprehend and use relevant mathematics and tools for reactor physics modeling.

Grade Distribution:

Assignments ×(8)	32%
Project ×(1)	8%
Quizzes ×(2)	30%
Final Exam (April 25, 14:40-17:30)	30%
Very Tentative Quiz Dates	September 25, October 23

Course Policies:

- **General**
  - The students are expected to attend classes in-person. Virtual (Zoom/Teams) invites will be distributed before every office hours.
  - Lecture (incomplete) notes are provided before each class. These notes will assist you to follow the lecture while completing the missing equations.
  - Interactive workshops will be provided in advance.
  - Office hours will primarily be conducted virtually (students must schedule in advance).
  - Quizzes and exams are closed book.
  - Quiz and exam notes will be provided by the lecturer.
- **Assignments**
  - Students are expected to work independently. Offering and accepting solutions from others is an act of plagiarism, and all involved parties will be penalized according to the Academic Honesty Policy. Discussion among students is encouraged, but when in doubt, direct your questions to the professor.
  - No late assignments will be accepted under any circumstances, unless communicated with me in advance.
  - You must make sure the assignments are properly scanned and submitted via Canvas.
  - Only a single pdf file is allowed to be submitted, unless instructed otherwise. The file name must include the home-work number and your name (e.g. NRE3208_SOL4_FirstLast.pdf)
- **Attendance and Absences**
  - Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.
  - The office hours is a great opportunity to explain any material that was not well understood or missed.

Honor Code:

Scholastic Dishonesty is any act designed to give an unfair academic advantage to a student, or the attempt to commit such an act. This includes copying from another student's exam; possessing or using unauthorized materials during an exam; using, buying, stealing, transporting or soliciting a test or the answer key; collaborating with another student during a test; copying someone else's homework or assignment; and permitting someone to take a test for you. The falsification of academic records is also an act of scholastic dishonesty. Students who participate in scholastic dishonesty will be reported and dealt with in accordance with Institute regulations. Specific instructions will be provided on projects. Specific instructions will be given when the project(s) is assigned as to what is acceptable interaction between student teams. The complete Georgia Tech Honor Code is found at http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code.

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.

Tentative Course Outline:
The weekly coverage might change as it depends on the progress of the class.

Topic	Content
Topic 1	**Fundamentals I** Nuclide density calculation, flux, reaction rates and cross-sections.
Topic 2	**Fundamentals II** Principle of nuclear reactor, fission, fissile and fertile materials.
Topic 3	**Neutron reactions and cross sections** Overview of neutron interactions, energy dependence of properties
Topic 4	**Neutrons slowing down** Center-of-mass and Lab coordinate systems, Kinematic of elastic scattering, moderating power ratio.
Topic 5	**Chain reactions** Multiplication factor, simple kinematics
Topic 6	**Neutron distributions in energy** Neutron energy spectra, averaged reaction rates, multiplication factor
Topic 7	**Review of 4- and 6-factor formulas** Neutron yield, thermal utilization, fast fission, resonance escape probability
Topic 8	**Breeding and conversion** Thermal vs. fast systems, uranium vs. thorium fuel cycles
Topic 9	**Spatial diffusion of neutrons** Derivation of diffusion equation, non-multiplying system, multiplying systems
Topic 10	**One-speed diffusion theory** Expansion functions and criticality.
Topic 11	**Heterogeneous systems** Finite difference methods to solve the 1-D and 1-group heterogeneous system.
Topic 12	**The two-group approximation** Diffusion equation in 2 energy groups.

Tentative list of HWs and projects:

H.W.	**Content**
1[3.5%]	Nuclide density calculation, flux, reaction rates.
2[3.5%]	Fundamentals and Janis OECD.
3[3.5%]	Kinematics of elastic scattering.
4[3.5%]	Multiplication factor (conversion and breeding included).
5[3.5%]	Flux and current
6[4.5%]	Diffusion equation
Proj.[8.0%]	Expansion methods (eigen-functions)
7[6.0%]	Buckling
8[4.0%]	Reflectors and the modified one-group condition.