Chemical Engineering 612—Nuclear Reactor Design and Analysis, Winter 2026

Location: 340 CTB
Time: 12:00-12:50 PM, MWF
Prerequisites: ChE 412, ChE 512, ChE 376 or equivalent, ChE 374 or equivalent

Instructor: Matthew J Memmott
330K Engineering Building; (801) 422-6237
memmott@byu.edu; http://www.et.byu.edu/~mjm82/che693R/che693R.html
Office Hours: T 3:00 PM – 4:00 PM, W-F 2:00 PM-3:00 PM, or by appointment.

TAs: TBD **(grading only)**

Course Objectives: This is a graduate level nuclear reactor design course. The four primary objectives for this course are the following:

1) To develop an understanding of nuclear reactor licensing requirements
2) To understand the 4 fundamental topics of reactor design:
    a. Core design
    b. System design
    c. Structural design
    d. Safety analysis
3) To work as a team to develop a viable paper reactor concept, and
4) To obtain practice in working as a team to design a complex reactor system

Although this subject can become quite involved, we will focus on the basics of nuclear reactor design. Due to the highly complex, involved, and multidisciplinary nature of nuclear reactor design, the best measure of learning for this course will be to actually develop a paper reactor concept for a nuclear reactor as a design group. This course will cover several topics pertinent to nuclear reactor design, including 1) licensing, 2) neutronics and core design, 3) thermal-hydraulics and primary system design, 3) System, structure, and component design (balance of plant), and 4) safety analysis.

Textbook: Due to the cost of textbooks, official textbooks will not be assigned for this course. However, material will be drawn from academic publications, federal licensing materials (including NRC documents), and the following texts:

1) Introduction to Nuclear Engineering 3rd Edition, John. R. Lamarsh & Anthony J. Baratta, Prentice Hall, 2001.
2) Nuclear Systems I Thermal Hydraulic Fundamentals, N. E. Todreas, M. S. Kazimi, Taylor & Francis 1993.
3) Nuclear Reactor Analysis, J. J. Duderstadt, L. J. Hamilton, John Wiley and Sons, 1976.

Reading: Lectures are designed to help students learn the course content, but many details and examples are given in the reference materials. Reading prior to discussion will facilitate greater understanding in lectures.

Homework: Homework assignments will be due weekly during the first 11 weeks of the course. Homework is designed to help you learn the course material through direct application. You are encouraged to work in groups, but you must turn in *your own* assignment, representing *your own* work. Late homework will be accepted up to the corresponding exam period for 50% credit. Homework solutions can be discussed with Dr. Memmott directly. You are on your honor not to use posted solutions in the working of late homework.

Exams: Two take-home, open book midterm exams will be administered to test mastery of the material taught in this course. There will be no final exam for this course.

Course Details: Class time will primarily cover the most important topics related to the core areas of nuclear reactor design and greater detail is contained in corresponding sections of the reading. These lectures will include interactive discussions, applications and case studies, and examples working problems similar to the homework. This course covers significant new material, and there is an emphasis on conceptual understanding for the midterm exams. However, for the design aspects of the course, often in depth understanding of the material is required. A major component of this course is the design of an original (unique and NOT derived from existing concepts) paper nuclear reactor design. The final conceptual design report will be submitted on the last day of class in lieu of a course final exam. Each student is expected to attend each class period and participate in the class. In-class sessions will provide opportunities for discussions. I will make reasonable accommodation for previously arranged and legitimate absences (your child being born, attending immediate family funeral, contagiously ill) but will be less sympathetic to after-the-fact or less legitimate absences (cute date, slept in, etc.). Each student is expected to engage is classroom and homework discussions. Your grade will depend in large extent on your active participation in solving the assigned problems and discussing their eventual solution.

Design Project: As a design course, the majority of your grade will be based upon your success in developing a nuclear reactor concept design. All of the materials covered in the first 14 lectures will be designed to build your understanding of nuclear reactor design principles, however, this material will be insufficient for the task. Thus, supplementary papers, reports, and industrial documents will likely be needed, and will form a supplementary source for design training in the design project. The last 2 weeks of class will be dedicated to working on the project. Attendance is required, as this is a perfect time to discuss questions, designs, theory, or even strategies. Two reports will be required on the last day of class:

1) Each group will be required to submit a detailed design report, which includes the standard operation, startup/shutdown, and safety parameters of their system design. There is no page requirement for these reports, but in order to facilitate the required design information, figures, pictures, and explanations, 20 + pages, is not unrealistic.

2) A final design document will be required, which will describe the entire plant design (i.e. the integration of all the systems and components into a single integrated design). This requires integration of all groups into a single, 5-page document that outlines the key parameters of the new reactor concept. The design report grade will depend on both of these documents.

Design Codes: As part of the homework assignments in this course, **one** code-based problem focused on a complex problem that cannot be solved by hand calculations will be assigned. This problem will focus on the use of a software used in the industry to design nuclear reactors. For this year, the code we learn will be OpenMC. Due to the challenge of learning this code, the instruction on how to use this code will be given at the beginning of class, so that ample time can be devoted to creating an operating model.

Grading: Grades for the course will be based on the following distribution:

Homework	25%
Midterm Exams	30%
Design Report	45%

Chemical Engineering 374 Competencies			
Comp.	**Level**	**Usage**	**Outcome**
1.3	1	P	Students will gain familiarity with the chemical engineering field, career options, and potential job functions, and awareness of contemporary issues that may have an impact on professional activities.
1.4	1	M	Students will develop an appreciation and respect for other disciplines and a knowledge of how chemical engineering relates to other disciplines
2.1	2	P	Students will gain a knowledge of linear algebra, multivariable calculus, and ordinary differential equations.
3.1.1	3	P	Be able to use basic engineering units in both SI and AES systems in solving problems, and be able to interconvert between unit systems
4.9	1	P	Students will demonstrate effective **interpretation of graphical data**.
6.1	3	P	Students will demonstrate an ability to **solve engineering problems**.
6.4	2	P	Students will exhibit critical and creative **thinking skills** for analysis and evaluation of problems and cause-effect relationships.
6.6	2	P	Students will be able to rationalize **units**, make order of magnitude **estimates**, assess reasonableness of solutions, and select appropriate levels of **solution sophistication.**
7.2	2	P	Students will understand and have a basic knowledge of how **safety considerations** are incorporated into engineering problem solving.
7.4	2	P	Students will understand and have a basic knowledge of how **environmental considerations** are incorporated into engineering problem solving.
12.8	1	P	Students will demonstrate effective **reading of technical materia**l.
Levels	1- exposure to material, but may not be assessed		
	2- competency assessed in course		
	3- competency is assessed in course at again before graduation		
Usage	M=main course content; P=developed throughout the program; I=Introduction		

BYU Policy Statements

Academic Honesty The first injunction of the BYU Honor Code is the call to be honest. Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life's work, but also to build character. President David O. McKay taught that "character is the highest aim of education" (The Aims of a BYU Education, p. 6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.

Honor Code Standards In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and my own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Preventing Sexual Harassment Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education. Title IX covers discrimination in programs, admissions, activities, and student-to-student sexual harassment. BYU's policy against sexual harassment extends not only to employees of the university, but to students as well. If you encounter unlawful sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Employment Office at 422-5895 or 367-5689 (24-hours); or contact the Honor Code Office at 422-2847.

Students with Disabilities Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the Services for Students with Disabilities Office (422-2767). Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. Services are coordinated with the student and instructor by the SSD Office. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB.