Chemical Engineering 512—Nuclear Reactor Transient Analysis, Fall 2023

Location: C254 ESC
Time: 9:30-10:45 AM, TTh
Prerequisites: ChEn 374 or equivalent, ChEn 376 or equivalent recommended, ChEn 412

Instructor: Matthew J Memmott
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https://www.et.byu.edu/~mjm82/che512/che512.html
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Office Hours: Dr. Memmott: M-F 12:00 PM-1:00 PM, or by appointment
Jackson Ivory; TBD

Course Objectives: This is a graduate level course focused on learning to do thermal-hydraulic analyses on nuclear reactor systems, using the systems analysis code RELAP5-3D. RELAP5 is an old, Fortran-based systems analysis code focused on transient analysis for light water reactor systems. It is like HYSIS or ASPEN, though with much less polish and it is much less user friendly. RELAP5 takes years of concerted effort to become fully competent, so this course is designed to build a modest ability to create and modify input decks. The four primary objectives for this course are the following:

1) Learn to develop RELAP5-3D input decks
2) Learn to interpret output files and plot/present data from RELAP runs
3) Learn to successfully run RELAP5-3D steady state and transient models
4) Learn to develop user-defined functions and custom fluid property files

Textbook: The RELAP5 user manuals will be the primary text for this class, with a special emphasis on Appendix A, which defines and describes the manner of creating input files. Occasional reference to RELAP5-focused academic papers may be utilized.

Reading: There will be no formal readings in this course. The lectures are designed to help students learn the course content, but most of the information will be initially presented in a series of RELAP5 training DVDs produced by the Idaho National Laboratory. Lectures will be based upon the content from these videos, and it is HIGHLY recommended that they be viewed prior to each lecture. These training videos will be made available in class or upon request from the instructors.

Homework: Homework assignments will be due nearly each week 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 2 weeks late for 50% credit. Homework solutions can be discussed with Jaron or Dr. Memmott directly. You are on your honor not to use posted solutions in the working of late homework.

Exams: There will be no exams for this course.

Course Details: Class time will primarily cover the most important topics related to the analysis of design basis and beyond design basis accidents using RELAP5-3D. For the first 2/3 of the class, great focus will be given to learning and creating models with RELAP5-3D while the last portion will be focused on analyzing a key transient for a specific reactor of your choosing from industry or from a concept proposed by labs or companies. For the RELAP5 instruction greater detail is contained in corresponding sections of the user manual, as well as the training DVDs created by the Idaho National Laboratory. The lectures will include interactive discussions, applications and case studies, and examples working problems as well as substantial assistance with understanding problems, errors, and challenges with the RELAP5-3D code. A major component of this course is the creation of an original RELAP5-3D model representing a specific advanced reactor concept, and then running a complete RELAP5-3D analysis of that model given a specific, pre-defined transient. The final project will consist of an in-class presentation summarizing the results of

this transient analysis, as well as a report that 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, questions about RELAP5-3D not specifically covered in class, and potential debugging help and guidance. I will make reasonable accommodation for legitimate absences (your child being born, attending immediate family funeral, contagiously ill) but will be less sympathetic to 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 nuclear reactor analysis course, the majority of your grade will be based upon your success in developing a RELAP5-3D model of a specific nuclear reactor concept. All of the materials covered in the first 14 lectures will be designed to build your understanding of nuclear reactor modeling and RELAP5-3D input deck construction, however, this material will be insufficient for the task. Thus, supplementary DVD training and study of the RELAP5-3D user manual appendix A will likely be needed, and will form a supplementary source for RELAP5-3D training in the design project. Additionally, papers, reports, articles, and online material will be needed to understand the nuances of the nuclear reactor design that you elect to analyze. The last 3 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 deliverables will be required on the last day of class:

1) Each student will be required to submit a detailed transient report, which includes the standard performance of the selected reactor concept, baseline values for key parameters, and the performance this concept (specific plots and values for baseline parameters) during a selected and pre-approved transient. There is no page requirement for these reports, but in order to facilitate the required design information, figures, pictures, and explanations, 10 + pages, is not unrealistic.

2) A transient performance presentation will be required, which will contain the same information as the report, but which will be in presentation format. This report should include a business-style presentation outlining the reactor, the transient, any weaknesses in the concept based on transient performance, and finally any recommendations on design changes based upon the transient performance of the reactor.

The design report grade will depend on both of these deliverables, and will be an average grade of the two, with a weighting of 60% for the paper and 40% for the presentation.

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

Homework	30%
Attendance/Participation	30%
Final Project	40%

Chemical Engineering 593R 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.