EP 713
Nuclear Safety Analysis and Reactor Accidents

Fall/Winter 2016/17
Course Outline

COURSE DESCRIPTION

This course presents a detailed description of the major elements of nuclear safety analysis. The role of safety analysis in demonstrating that a nuclear generating station meets applicable regulatory requirements is discussed together with an overview of the regulatory requirements in international jurisdictions such as the USA, UK, France and Canada. A full range of Postulated Initiating Events in the various systems of major water reactor types (PWR, LWR and CANDU) are considered, with an emphasis on the safety concerns, the transient event progression, phenomena of importance to safety, and criteria used to judge the adequacy of mitigating actions. A major focus of the course is on the progression of accidents to Beyond Design Basis Accidents (BDBA) and severe accidents involving core degradation. The important phenomena that are encountered in severe accidents, such as: high temperature thermal-mechanical stresses and deformation of structural materials; high temperature metal oxidation; the relationship between chemical thermodynamics of fission products in fuel and their release; gas generation by oxidation reactions and potential combustion events are discussed in detail. The challenges of external event hazards are discussed in the context of severe accident event initiators. The TMI-2, Chernobyl and Fukushima accidents are used as case studies in discussing severe accident phenomena. Analytic methods are provided that allow scoping analysis to be performed. (3 hour lecture / week)

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

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Office Hours:
Monday – Friday 10:30 am to 6:00 pm
Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

None

COURSE OVERVIEW

Date/Week	Topic	Readings
1	PART 1 – Design Basis Accidents (DBA): Overview of Safety Analysis Elements, Plant Systems, Structures and Components Important to Safety	Course notes Ch 1,2,3
2	Reactivity Initiated Accidents (RIA) and Loss of Control Events	Course notes Ch 4
3	Loss of Reactor Coolant Flow Events	Course notes Ch 4
4	Steam And Feedwater System Failures	Course notes Ch 5
5	Small Break Size Loss of Coolant Accidents	Course notes Ch 6

6	Large Break Size Loss of Coolant Accidents	Course notes Ch 7
7	PART 2 - Beyond Design Basis Accidents (BDBA): Classification, risk analysis and risk goals	Course notes Ch 8
8	Power Reactor Accidents: Three Mile Island U2, Chernobyl U4, Fukushima U1, 2, 3	Course notes Ch 9, 10, 11
9	Degradation of Fuel Cooling and Core Heatup Behaviour: Chemical Thermodynamics of Core Materials. High Temperature Metal Oxidation; Fission Product Release and Transport	Course notes Ch 12
10	In-Vessel Retention Issues: Core Disassembly, Formation of Core Melt and Melt Relocation	Course notes Ch 13
11	Ex-Vessel Debris Relocation and Containment Integrity Issues: Molten Core-Concrete Interaction (MCCI), Direct Containment Heating (DCH); Gas Combustion; and combustible gas control	Course notes Ch 14
12	Accident Mitigation: Severe Accident Management Guidelines and emergency Response Measures	Course notes Ch 15

ASSESSMENT

Component	Weight
Assignments	40%
Individual oral assessment of assigned readings	20%
Final Exam	40%
Total	100%

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.

3. Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities.

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

1. If you are seeking relief for missed academic work because of an absence lasting less than five days in duration, you must use the McMaster Student Absence Form.
2. Absences lasting more than five days must be reported to the Associate Dean's Office (JHE-A214) and appropriate documentation must be provided. For medical absences, the University reserves the right to require students to obtain medical documentation from the Student Wellness Centre.
3. You should expect to have academic commitments Monday through Saturday but not on Sunday or statutory holidays. If you require an accommodation to meet a religious obligation or to celebrate an important religious holiday, you may use the McMaster Student Absence Form or contact the Associate Dean's Office.
4. At the third request for relief of academic missed work, you will be asked to meet with the Assistant or Associate Dean (or delegate). Relief for missed academic work is not guaranteed.
5. You are responsible to contact your instructor(s) promptly to discuss the appropriate relief.
6. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

TURNITIN.COM STATEMENT

In this course we will be using a web-based service (Turnitin.com) to reveal plagiarism. Students will be expected to submit their work electronically to Turnitin.com and in hard copy so that it can be checked for academic dishonesty. Students who do not wish to submit their wok to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal

verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to http://www.mcmaster.ca/academicintegrity/.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using e-Mail and Avenue to Learn. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.