Engineering Physics
ENG PHYS 713
Nuclear Safety Analysis and Reactor Accidents
Graduate Studies
Fall 2025 or Winter 2026
Course Outline

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

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Office Hours:
Monday – 12:00 pm to 1 pm and 4 pm to 5 pm
Or by appointment

CALENDAR/COURSE DESCRIPTION

This course will examine the nuclear safety analysis requirements established by regulatory bodies in Canada and internationally. It will cover the major types of power reactors, including Light Water Reactors (PWR and BWR) and Pressurized Heavy Water Reactors (CANDU). The focus will be on Design Basis Accidents, as well as Beyond Design Basis Accidents, which include Severe Accidents.

We will explore the concept of the Postulated Initiating Event, the development of accident sequences, acceptance criteria, and barrier effectiveness, and discuss how these elements are used to meet regulatory and design objectives. Additionally, case studies will be conducted on four significant historical accidents that have greatly influenced nuclear safety design and analysis.

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

The official means of communication with students is via the course webpage on Avenue to Learn.
It is the students' responsibility to check the course webpage for updates and announcements regularly.

CLASS FORMAT

Course Dates: 05/01/2026 - 22/04/2026
Units: 3 (all one-term graduate courses are 3 units)
Course Delivery Mode: All classes are virtual, and tutorial classes are in-person
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regulatory and design objectives. Additionally, case studies will be conducted on four significant historical accidents that have greatly influenced nuclear safety design and analysis.

NUCLEAR SAFETY OVERVIEW

1. Objectives of Safety Analysis
2. Types and Stages of Deterministic Safety Analysis
    - 2.1. The concept of risk acceptability and the history of Probabilistic Safety Assessment in estimating the reliability of design requirements.
3. The Plant Systems, Structures and Components Important to Safety and Barriers Preventing the Transmission of Radionuclides
    - 3.1. Pressurized Heavy Water Reactors (PHWR)
    - 3.2. Pressurized Water Reactors (PWR)
    - 3.3. Boiling Water Reactors (BWR)
4. Postulated Initiating Events (PIEs) and Acceptance Criteria for Design Basis Events
    - 4.1. Approaches to Identifying Initiating Events
    - 4.2. Classification of Initiating Events
    - 4.3. Basic Acceptance Criteria and Derived Acceptance Criteria
    - 4.4. Types of Acceptance Criteria for Safety, Reliability and Quality
5. Accident Analysis
    - 5.1. Primary Circuit Events
    - 5.2. Secondary Side and Feedwater Failure Events
    - 5.3. Fuelling Machine Events
    - 5.4. Reactivity Control Events
    - 5.5. Supplementary and Design Basis Earthquake Events
6. Beyond Design Basis Accidents (BDBA)
7. Severe Accidents
8. Reactor Accident Case Studies
    - 8.1. Three Mile Island Unit 2 (USA)
    - 8.2. Chernobyl Unit 4 (Soviet Union)
    - 8.3. Fukushima Daiichi (Japan)
    - 8.4. NRX (Canada)

The course is scheduled as follows:

- C01: lecture Monday 2:00 – 5:00 pm see Mosaic or Avenue for location

Recordings of the lecture are permitted for personal study, and students are requested to respect the privacy rights and intellectual property of others.

There are no formal prerequisites; however, prerequisite knowledge of basic thermofluids, mechanics of materials, and mathematics is beneficial.

To complete the course, a minimum attendance rate of 75% is required.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to:

- Understand the differences and similarities between Pressurized Water Reactors (PWRs), Boiling Water Reactors (BWRs), and CANDU reactors.
- Learn the purpose of conducting Nuclear Safety Analysis and identify the root causes of key real-world nuclear accidents.
- Gain an understanding of the hazards associated with nuclear power reactors.
- Develop a systematic approach to creating a list of credible accidents for a nuclear power plant design.
- Appreciate postulated accident scenarios and the plant-specific safety features designed to prevent accidents or mitigate their consequences.
- Familiarize themselves with the physical and mathematical models used in safety analysis.

COURSE SCHEDULE

A weekly breakdown of the course schedule

Date/Week	Topic	Readings
Week 1 – Jan 5-9	Objectives of Safety Analysis, Types and Stages of Deterministic Safety Analysis	
Week 2 - Jan 12-16	The concept of risk acceptability and the history of Probabilistic Safety Assessment in estimating the reliability of design requirements	
Week 3 - Jan 19-23	The Plant Systems, Structures and Components Important to Safety and Barriers Preventing the Transmission of Radionuclides – Part 1	
Week 4 - Jan 26-30	The Plant Systems, Structures and Components Important to Safety and Barriers Preventing the Transmission of Radionuclides – Part 2	
Week 5 - Feb 2-6	Postulated Initiating Events (PIEs) and Acceptance Criteria for Design Basis Events	
Week 6 - Feb 9-13	Accident Analysis – Part 1	
Week 7 – Feb 23-27	Accident Analysis – Part 2	
Week 8 - Mar 2-6	Accident Analysis – Part 3	
Week 9 - Mar 9-13	Accident Analysis – Part 4	
Week 10 - Mar 16-20	Beyond Design Basis Accidents (BDBA)	
Week 11 - Mar 23-27	Severe Accidents	
Week 12 - Mar 30-Apr 3	Reactor Accident Case Studies	

This lecture schedule is based upon current university and public health guidelines and may be subject to changes during the term. Any changes to the schedule or course delivery will be communicated on the course announcements section on Avenue to Learn. Please check the announcements prior to attending class.

REQUIRED/OPTIONAL MATERIALS AND FEES

Required Texts:
None

Recommended Additional Texts:
To be provided during the lectures

Calculator:
Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

Other Materials:
None

COURSE ASSESSMENT DETAILS

Component	Due Date	Weight
Preliminary Test	January 30	30%
Mid Term Test	March 6	30%
Final Exam	April 10	40%
Total		100%

GRADING SCALE

Grade	Points	Equivalent Percentages	Pass/Fail
A+	12	90 – 100	P+
A	11	85 – 89	P
A-	10	80 – 84	P
B+	9	77 – 79	P
B	8	73 – 76	P
B-	7	70 – 72	P
F	0	69 and under	F

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

- The Students are expected to meet the test and exam deadlines.

GENERATIVE AI

These sample statements may be included on a course syllabus to communicate with students the expectations around generative AI in a course. Instructors may adapt or modify these statements according to their individual teaching goals and course learning outcomes.

CHOOSE ONE OF THE FOLLOWING and modify as needed.

1. USE PROHIBITED

Students are not permitted to use generative AI in this course. In alignment with McMaster academic integrity policy, it "shall be an offence knowingly to … submit academic work for assessment that was purchased or acquired from another source". This includes work created by generative AI tools. Also state in the policy is the following, "Contract Cheating is the act of "outsourcing of student work to third parties" (Lancaster & Clarke, 2016, p. 639) with or without payment." Using Generative AI tools is a form of contract cheating. Charges of academic dishonesty will be brought forward to the Office of Academic Integrity.

2. SOME USE PERMITTED

Example One

Students may use generative AI in this course in accordance with the guidelines outlined for each assessment, and so long as the use of generative AI is referenced and cited following citation instructions given in the syllabus. Use of generative AI outside assessment guidelines or without citation will constitute academic dishonesty. It is the student's responsibility to be clear on the limitations for use for each assessment and to be clear on the expectations for citation and reference and to do so appropriately.

Example Two

Students may use generative AI for [editing/translating/outlining/brainstorming/revising/etc] their work throughout the course so long as the use of generative AI is referenced and cited following citation instructions given in the syllabus. Use of generative AI outside the stated use of [editing/translating/outlining/brainstorming/revising/etc] without citation will constitute academic dishonesty. It is the student's responsibility to be clear on the limitations for use and to be clear on the expectations for citation and reference and to do so appropriately.

Example Three

Students may freely use generative AI in this course so long as the use of generative AI is referenced and cited following citation instructions given in the syllabus. Use of generative AI outside assessment guidelines or without citation will constitute academic dishonesty. It is the student's responsibility to be clear on the expectations for citation and reference and to do so appropriately.

3. UNRESTRICTED USE

Students may use generative AI throughout this course in whatever way enhances their learning; no special documentation or citation is required. Students should prepare their assignments themselves and be able to explain the work they submit.

Also see Guidelines on the Use of Generative AI in Teaching and Learning - Academic Excellence - Office of the Provost for more information. Please note how this intersects with the following guidance on academic dishonesty.

APPROVED ADVISORY STATEMENTS

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Engineering Physics and the Faculty of Engineering are committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the Equity and Inclusion Office.

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. **It is your responsibility to understand what constitutes academic dishonesty.**

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. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/

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.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, 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 a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in

the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

Physical and Mental Health

For a list of McMaster University's resources, please refer to the Student Wellness Centre.

Academic Accommodation for Religious, Indigenous or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.