

# MECH 4105 - Nuclear Engineering -Rev. 1

## Winter 2022

### Course Outline

#### Introduction

Over half of the electricity in Ontario is provided by nuclear reactors. The Canadian nuclear industry is comprised of 4 major electricity producers with over \$4 billion in electricity sales, a national laboratory in Chalk River, and more than 150 private companies employing more than 32 000 people. Canadian technology is based on the home-grown CANDU heavy water reactor. CANDU reactors have been operating in Canada since 1962, and abroad since 1972. There are 49 heavy-water moderated reactors based on the CANDU design in operation, under construction, or under refurbishment worldwide.

In addition, Canadians were pioneers in nuclear medicine starting with cobalt-60 irradiation treatment of cancers in the 1960's, and later with the host of medical diagnostic procedures that include  $^{99m}\text{Tc}$  imaging of heart and bone diseases. The NRU reactor at Chalk River was the source for approximately 33% of the world supply of  $^{99m}\text{Tc}$ , which was used in approximately 80% of the 46 million nuclear medicine tests performed every year worldwide, of which 2 million were performed in Canada.

This course provides an overview of nuclear engineering concepts and practices used to generate electricity and to make nuclear medicine possible. The course will include basic fundamentals, as well as lectures on specific topics, depending on the availability of guest industry experts; an example of what might be taught is given in the outline of lectures shown below. Students with an enthusiasm for basic physics, chemistry and biology, and a good understanding of ordinary differential equations and their solutions, will benefit most from the material presented.

**Instructor:** Professor Glenn McRae [glenn.mcrae@carleton.ca](mailto:glenn.mcrae@carleton.ca)

**TA:** Leigh Corrigan [leighcorrigan@cmail.carleton.ca](mailto:leighcorrigan@cmail.carleton.ca)

**Lectures:** 3 hours/week (Monday and Wednesday, 11:35-1:55, On-line: Zoom on Brightspace)

#### Exams

The mid-term exam will be held in February (likely Feb 9). The final exam will be scheduled by the university during the final exam period. Both the mid-term and final exams will be closed book examinations comprised of hand-written essay and analytical (number) questions.

#### Marking Scheme

The final course grade will be determined according to the following:

Mid-term exam	40%
Final exam	60%

A passing mark (50% and higher) is required on the final exam to pass the course. According to the policy of the Faculty of Engineering and Design, the final examination is for evaluation purposes only and the marked final examination papers will not be returned to the students.

### Course outline

The current plan is for the following topics to be presented over 12 weeks by Professor McRae and guests from industry. Topics might change depending on availability of guest presenters. Approximate dates and lecture subjects are listed below:

Weeks	Date	Topics
1	Jan 10-12	Overview of the course and General Introduction
2	Jan 17	Nuclear Physics, Generic Aspects of Reactors, and review of basic differential equations used in reactor physics calculations
3	Jan 19	
	Jan 24	
4	Jan 26, 31	Commercial Reactors, PWR, BWR
5	Feb 2, 7	CANDU, Void Reactivity
5	Feb 9	<b>Midterm</b>
6	Feb 14	Xenon oscillations
6	Feb 16	Reactor Materials
	Feb 21, 23	No lectures – Midterm Break
7	Feb 28, Mar. 2,7	Corrosion and Delayed Hydride Cracking
8	March 9	Fuel and the Fuel Cycle (Waste management and Thorium)
9	March 14, 16	Radiation Protection and Hormesis
10	March 21, 23	Safety, Review of past accidents: TMI, Chernobyl, Fukushima; role of the regulator
11	March 28, 30	Nuclear Medicine Applications
12	April 4	Guest lecture
12	April 6	Final Review

## **Requests for Academic Accommodation**

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

### **Pregnancy obligation**

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website: [carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

### **Religious obligation**

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website: [carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

### **Academic Accommodations for Students with Disabilities**

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. [carleton.ca/pmc](https://carleton.ca/pmc)

### **Survivors of Sexual Violence**

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and its survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [carleton.ca/sexual-violence-support](https://carleton.ca/sexual-violence-support)

### **Accommodation for Student Activities**

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

For more information on academic accommodation, please contact the departmental administrator or visit: [students.carleton.ca/course-outline](https://students.carleton.ca/course-outline)