

Engineering Physics
NUCENG 4D04
Nuclear Reactor Physics
Winter 2027



ENGINEERING

Instructor Information



Michael Welland
Email: wellandm@mcmaster.ca
Office: NRB B120
Office Hours:
Tuesdays 11am-1pm

TA Information

Name: TBD

Class Times

Activity	Day(s)	Time	Location
Lecture	Monday, Thursday	9:30 AM - 10:20 AM	ETB 124
Lecture	Tuesday	10:30 AM - 11:20 AM	ETB 124

Activity (Section)	Day	Time	Location
Lab (L01)	Monday	2:30 PM - 5:20 PM	NRB 117

Activity (Section)	Day	Time	Location
Lab (L02)	Tuesday	2:30 PM - 5:20 PM	NRB 117
Lab (L03)	Wednesday	2:30 PM - 5:20 PM	NRB 117

Class Format

In Person

In-person attendance is required for this course.

Course Dates: 01/04/2027 - 04/07/2027

Units: 4.00

Course Delivery Mode: In Person

Course Description: Introduction to nuclear fission and the physics of nuclear reactors; reactor statics for homogeneous reactors; reactor kinetics for simple time-dependent situations; effects of saturating fission products (Xe-135); reactivity coefficients. Students perform labs involving the McMaster Nuclear Reactor to gain an understanding of the nuclear physics processes underlying its operation and its applications. Three lectures, one tutorial, one lab (three hours) four times per term; winter term Prerequisite(s): NUCENG 3D04 or ENGPYS 3D04 Antirequisite(s): ENGPYS 4D03, 4D04

Instructor-Specific Course Information

Communication: A2L announcements or MSTeams Channel

Project submission and grade tracking on A2L

Important Links

- [Mosaic](#)
- [Avenue to Learn](#)
- [Student Accessibility Services - Accommodations](#)
- [McMaster University Library](#)

- [eReserves](#)
- [Open Education Resources](#)

Course Learning Outcomes

- Describe and use in problems the important quantities which relate to the fission chain reaction, e.g., neutron flux and current, absorption, fission and radiative-capture cross sections, reactor multiplication constant, reactivity, buckling, fuel irradiation and burnup.
- Describe the CANDU design. Explain the functions of its reactivity devices, coolant void and fuel reactivity changes with fuel irradiation/burnup.
- Explain the $^{135}\text{Xe}/^{135}\text{I}$ kinetics and solve problems relating to the effects of xenon in steady state and in transients
- Explain the neutron-diffusion equation and the various terms in it.
- Light Water Reactor (LWRs including BWRX) reactor physics design including differences in control absorbers, burnable poisons, the effect of enrichment, and burnup effects
- Perform point-kinetics calculations, both in the time and s-domain.
- Solve time-dependent problems to calculate the evolution of flux and power following insertion of reactivity in a reactor.
- Solve time-independent problems in multiplying media to find the neutron-flux distribution and its absolute value, the reactor multiplication constant, and/or the reactor dimensions, given sufficient reactor data.
- Solve time-independent problems in non-multiplying media but with external neutron sources, to find the neutron-flux and current distribution in space.
- Use the equation for subcritical multiplication to derive the value of system reactivity and/or device reactivity in an approach to critical.

Graduate Attributes

The Canadian Engineering Accreditation Board (CEAB) is a division of Engineers Canada and is responsible for accrediting undergraduate engineering programs across Canada. Accreditation by the CEAB ensures that the engineering programs meet a national standard of quality and cover essential educational requirements. Graduate Attributes are a set of qualities and skills that the CEAB expects engineering graduates to possess. These attributes are a benchmark for the

learning outcomes of accredited engineering programs. This section lists the Graduate Attribute Indicators associated with the Learning Outcomes in this course.

The Graduate Attributes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Outcome	Indicator
Outcomes Indicators Competence in Specialized Engineering Knowledge	1.4
Selects appropriate model and methods and identifies assumptions and constraints	3.1
Successfully uses engineering tools	5.2

Lab Information

There are a total of 4 labs to be completed as a combination of in-reactor experiments and numerical simulation. The lab manuals and instructions are available online through Avenue to Learn.

Note: Any student with an MSAF will be given an automatic extension of the submission deadline of 1 week past the original due date. No other changes in due dates will be provided.

Lab Safety

The Faculty of Engineering is committed to McMaster University's Workplace and Environmental Health and Safety Policy which states: "Students are required by University policy to comply with all University health, safety and environmental programs". It is your responsibility to understand McMaster University Workplace and Environmental Health and Safety programs and policies. For information on these programs and policies please refer to [McMaster University Health and Safety](#). The Lab Safety Handbook is available [here](#), as well as on A2L.

It is also your responsibility to follow any specific Standard Operating Procedures (SOPs) provided for some of the experiments and the laboratory equipment. A laboratory-specific set of rules can also be added to ensure that students fully understand laboratory safety rules that are in place prior to their first session.

Course Schedule

Week	Topic
1	Introduction to Reactor Physics and Nuclear Reactions
2	Neutronic Concepts and Intro to Neutron Transport
3	Neutron Transport and Source Sink Problems
4	The Finite Reactor (with leakage and delayed components)
5	Feedback Mechanisms and Reactor Statics
6	Diffusion in 1 and 2 Energy Groups
	<i>Midterm break</i>
7	Subcritical Cores, Multiplication, Approach to Critical
8	Reactor Kinetics with Prompt and Delayed Components
9	Xenon and Iodine Kinetics
10	Irradiation and Burnup Effects in CANDU
11	Irradiation and Burnup Effects in Light Water Reactors
12	Reactivity Components and Reactor Control
13	Review

Required Materials and Texts

Please sign in with your MacID [here](#) to view your booklist

Course notes

Students are not required to acquire a textbook. The material is provided by the instructor in the form of lecture slides/notes and occasional excerpts from textbooks.

Optional Course Materials

Please sign in with your MacID [here](#) to view your booklist

Fundamentals of Nuclear Engineering

ISBN: 9781119271499

Authors: Brent Lewis, Nihan Onder, Andrew Prudil

Publisher: Wiley

Introduction to Nuclear Engineering

ISBN: 0-20182- 498-1

Authors: John R. Lamarsh & Anthony J. Baratta

Publisher: Prentice Hall

Nuclear Reactor Analysis

ISBN: 0- 471-22363-8

Authors: James J. Duderstadt & Louis J. Hamilton

Publisher: John Wiley & Sons, Inc.

The Essential CANDU - a textbook about the CANDU nuclear reactor

(chapters 4 and 5) <http://www.nuceng.ca/candu/>

Course Evaluation

- Labs: 25%
- Assignments*: 10%
- Quiz (~4-5 in the tutorial): 25%
- Final Exam: 40%

*Completed assignments must be handed in on schedule to receive full marks. Solutions will be provided after the due date so students can self-check their answers. **Assignments will not be explicitly graded.**

Note for 6D04 (Graduate) students: An extra assignment (project) worth an additional 20 marks. The total mark will be renormalized to a maximum of 100%

Undergraduate Grading Scale

The McMaster 12 Point Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

Graduate Grading Scale

Graduate Student Grading Scale (Except for MBA and Master of Finance)

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

MBA and Master of Finance Grading Scale

Grade	Points	Equivalent Percentage	Pass/Fail
A+	12	90-100	P+
A	11	85-89	P
A-	10	80-84	
B+	9	75-79	
B	8	70-74	
B-	7	60-69	
F	0	59 and under	F

Late Assignments

*Completed assignments must be handed in on schedule to receive full marks. Solutions will be provided after the due date so students can self-check their answers. **Assignments will not be explicitly graded.**

Absences, Missed Work, Illness

All components of the course are mandatory, including the lectures which are in-person. Students with a valid MSAF for a quiz will have the weight shifted to the remaining quizzes. Students with an MSAF for a lab or assignment will be given an automatic 1 week extension to submit their work. Any other exceptions will be given a zero.

Generative AI: Unrestricted Use

Students may use generative AI throughout this course in whatever way enhances their learning; no special documentation or citation is required.

The student bears the full accountability of the submitted work.

Turnitin.com

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.

APPROVED ADVISORY STATEMENTS

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](#).

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Authenticity / Plagiarism

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. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

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Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, 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.

Requests for Relief for Missed Academic Term Work

In the event of an absence for medical or other reasons, students should review and follow the [Policy on Requests for Relief for Missed Academic Term Work](#).

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, Avenue to Learn and/or McMaster email.