

**ENGPYHS 3D04
Principles of Nuclear Engineering
Undergraduate Studies
Fall 2024
Course Outline**

CALENDAR/COURSE DESCRIPTION

Introduction to fission and fusion energy systems. Energetics of nuclear reactions, interactions of radiation with matter, radioactivity, design and operating principles of fission and fusion reactors.
Three lectures, one lab (three hours) four times per term; first term

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in Level II or above of an Engineering program
Antirequisite(s): ENGPYHS 3D03

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Markus Piro, Instructor
NRB 105
pirom@mcmaster.ca

Office Hours:
To be announced on A2L

Dr. Matthew Moran, Laboratory Supervisor
moranm@mcmaster.ca

Office Hours:
By appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Morgan Collins, collim28@mcmaster.ca

Luisa Vargas Suarez, vargassl@mcmaster.ca

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

The primary method of communication will be Avenue To Learn (A2L, <http://avenue.mcmaster.ca/>). It is the student's responsibility to regularly check on A2L for updates.

COURSE INTENDED LEARNING OUTCOMES

Upon successful completion of the course, you will be able to:

1. Conceptualize and explain the fundamental physical phenomena related to nuclear physics, including fission, radioactive decay, and related mechanisms.
2. Describe and explain the fundamental physical and chemical processes relevant to nuclear fuel cycle and radioactive waste management.
3. Understand the physics, chemistry, and biology of radiation, interaction of radiation with matter (including human body), and fundamentals of radiation detection. Apply these physics, chemistry, and biology principles to design radiation shielding (labs & assignment).

MATERIALS AND FEES

REFERENCE TEXTS:

- [Required] J.R. Lamarsh, A.J. Baratta, Introduction to Nuclear Engineering, Pearson, 4th Ed.
- [Optional] Wj. Garland, The Essential CANDU, UNENE.

CALCULATOR:

Only the McMaster Standard Calculator (the Casio FX-991 MS or MS Plus calculator) will be permitted in tests and examinations. These are available at the Campus Store.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- Three lectures per week
- One tutorial per week
- Four labs per term

To maximize your success in this course, you should:

1. Regularly review A2L for course information;
2. Attend lectures and tutorials, review lecture slides, read chapters assigned in the textbook;
3. Read the lab manual prior to every lab and ask questions if anything is unclear;
4. Work with your peers to ensure you understand course content;
5. Aim to understand concepts, only memorize knowledge;
6. Students who are struggling with any course content are encouraged to ask questions during lectures, tutorials, and office hours.

Course assessments are as follows:

1. **Assignments** will be regularly given to ensure students apply concepts learned in class. These assignments will be primarily based on the course textbook. It is highly recommended that students read through the lecture slides and textbook to complete their assignments. Students are encouraged to work together but must include a written acknowledgement of their peers in the assignment (e.g., "This assignment was completed together with <name>". Please put a box around your final answer. Students will receive feedback on their assignments, which they should learn from in subsequent deliverables.
2. **Lab reports** will be written individually by students based on the labs that they performed in co-ordination with the Lab Supervisor. Students are expected to review the lab manual (available on A2L) prior to every lab and are encouraged to ask questions. The written report should follow the document writing guidelines for 3D04 and will be evaluated using the lab report evaluation form (both provided on A2L). Students will receive feedback on their reports, which should be applied in subsequent reports. The labs are intended to apply the theory learned in-class.
3. There will be **two tests** and a **final exam**. The tests and exam will be based on content discussed in-class, material referenced from the textbook, and the assignments. Labs will be out of scope. The scope will be clearly communicated in-class. Tests and the final exam will be open book (e.g., printed lecture slides,

textbook, assignments). Calculators will be permitted but no other electronics (e.g., laptops, smart phones, smart watch, etc.).

COURSE SCHEDULE

The following is an approximate schedule of lectures, which may change. Lectures will be held on the following days:

- Mondays @ 9:30 – 10:20 h, T13 room 106
- Tuesdays @ 10:30 – 11:20 h, T13 room 106
- Thursdays @ 9:30 – 10:20 h, T13 room 106

The lecture schedule is given below. Note that this is intended to give a best estimate of the schedule, which may change throughout the semester.

Date	Book Chapter	Major Topic	Subtopic
Tues, Sept 3	1	Admin and Introduction to nuclear	Review course outline, intro to nuclear profession
Thurs Sept 5	2	Atomic and nuclear physics	Fundamental particles, radioactive decay
Mon Sept 9	2		Radioactivity calculations, Binding energy
Tues Sept 10	3	Interaction of Radiation with Matter	Neutron interaction with matter
Thurs Sept 12	3		Energy loss in scattering collisions
Mon Sept 16	3		Fission
Tues Sept 17	3		Gamma interaction with matter
Thurs Sept 19	3		charged particle interactions
Mon Sept 23	4	Nuclear reactors and Nuclear Power	Intro to different reactor types
Tues Sept 24	4		Major components of a nuclear reactor
Thurs Sept 26	4		Nuclear fuel cycle -- front end
Tues Oct 1	4		Nuclear fuel cycle -- back end
Thurs Oct 3	1-4	Prepare for test	
Mon Oct 7	1-4	TEST 1	
Tues Oct 8	5	Neutron diffusion and moderation	Diffusion equation
Thurs Oct 10	5		Group-diffusion method
Mon Oct 21	6	Nuclear reactor theory	Calculating flux and power
Tues Oct 22	6		Four factor formula
Thurs Oct 24	7	The Time-dependent Reactor	Reactor kinetics
Mon oct 28	7		Control rods and chemical shims
Tues Oct 29	7		Factors on reactivity

		Heat Removal from Nuclear Reactors	Heat generation in reactors
Thurs Oct 31	8		
Mon Nov 4	8		Thermodynamic cycles
Tues Nov 5	8		Boiling heat transfer
Thurs Nov 7	9	Radiation Protection	Natural and man-made radiation sources
Mon Nov 11	9		Biological effects of radiation
Tues Nov 12	9	Guest lecture	P. Reid, AtkinsRealis
Thurs Nov 14	9		Exposure and dose
Mon Nov 18	5-8	TEST 2	
Tues Nov 19	10	Radiation Shielding	Radiation sources
Thurs Nov 21	10		Gamma shielding
Mon Nov 25	10		Coolant activation
Tues Nov 26	11	Safety and licensing	Licensing overview
Thurs Nov 28	11		REGDOCS
Mon Dec 2	11		Reactor accidents – part I
Tues Dec 3	11		Reactor accidents – part II
Thurs Dec 5	1-11	Course review	

Tutorial schedule:

The tutorials run every week on Thursdays at 12:30 – 13:20 h in KTH B104.

Lab schedule:

The four (4) labs will be delivered in-person. A schedule will be prepared and posted on A2L at the beginning of the term. The four labs to complete are:

1. Introduction to gamma detection,
2. Radioactive half-life,
3. Neutron attenuation, and
4. Neutron radiography.

Each laboratory will occur over a single 3-hour session. **Attendance and completion of each laboratory experiment and submission of all lab reports are mandatory.** If the lab facilities become unavailable for any reason, data will be made available by the instructor and laboratory supervisor, and the students will complete the lab reports based on the supplied data. Laboratory manuals are available on A2L. Deliverable due dates will be communicated on A2L.

ASSESSMENT

Assessment Item	Weighting
Assignments (10)	10%
Lab Reports (4)	30%
Tests (2)	30%
Final Exam (1)	30%

Note that the MSAF policy for this course is as follows: MSAF'd assignments will be reweighted to the rest of the course deliverables. MSAF'd lab reports will be given an additional three business days to submit.

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 is 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](#).

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

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.

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.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

It is the students' responsibility to regularly check the course forum for updates and announcements. Under normal circumstances, late assignments will not be accepted and late lab reports will receive a 20% late penalty per day.

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

1. Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:
 - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
 - Students may submit requests for relief using the MSAF once per term.
 - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
 - a. **Normal MSAF relief policy for this course is covered in the assessment section.**
 - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
 - The MSAF cannot be used for academic work that has already been completed or attempted.
 - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
 - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.
2. For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:
 - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
 - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

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.
