

Carleton University Physics Department
PHYS 6701 - Quantum Field Theory (Fall 2024)
Course Outline

Instructor: Prof. Daniel Stolarski (he/him)

Email: stolar@physics.carleton.ca

Lecture Schedule: Monday & Wednesday, 4:05 PM - 5:25 PM.

This is an in person course, students are expected to attend lectures in person.

Course Calendar Description: Relativistic quantum field theory; second quantization of Bose and Fermi fields; reduction and LSZ formalism; perturbation expansion and proof of renormalizability of quantum field theories; calculations of radiative corrections and applications.

Prerequisites: PHYS 5701 and PHYS 5702 or equivalent.

Recommended Textbook: Matthew D. Schwartz, “Quantum Field Theory and the Standard Model,” Cambridge University Press, 2013.

Useful References: There are many great QFT books, these are some of my favourites, but this list is by no means complete.

Michael E. Peskin and Daniel V. Schroeder, “An Introduction to Quantum Field Theory” Addison-Wesley, 1995.

Anthony Zee, “Quantum Field Theory in a Nutshell,” Princeton University Press, 2010.

Steven L. Weinberg, “The Quantum Theory of Fields: Volume 1, Foundations,” Cambridge University Press 2005.

Steven L. Weinberg, “The Quantum Theory of Fields: Volume 2, Modern Applications,” Cambridge University Press 2005.

Course webpage: [See Brightspace](#)

Student Hours¹: By email appointment.

Assignments and Grading

Homework Assignments: 60%

Assignments will be posted on Brightspace, with the due date and time noted there. Please scan and submit your solutions via Brightspace in a **single pdf file**. Assignments will be given roughly every other week.

Working through problems is an essential part of developing a deep understanding of the material in this course. Students are encouraged to work together to understand the problems; however, the work handed in must be original.

Final Exam: 40%

There will be a take home final exam during the finals period in December. Students will be given 3 days to complete the exam. It will be open book and open notes, but you may not consult with any other people or use the internet.

¹Sometimes also called office hours.

Inclusive teaching statement:

Science is for everyone. I am committed to fostering an environment for learning that is inclusive for everyone regardless of gender identity, gender expression, sex, sexual orientation, race, ethnicity, ability, age, class, etc. All students in the class, the instructor, and any guests should be treated with respect during all interactions. It is my hope that our class will support diversity of experience, thought, and perspective. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback. I welcome emails or in-person communications to let me know your preferred name or pronoun. Please see the [Faculty of Science Equity, Diversity, and Inclusion \(EDI\) statement](#).

Course Outline

Below is a rough outline of the course, but it may change to fit the pace needed.

Class	Text Sections (Schwartz)	Topic Description
Sep 4	6	LSZ Reduction Formula
Sep 9, 11	8	Gauge Invariance
Sep 16	8	The Photon
Sep 18		No Class
Sep 23, 25, 30	14	Path Integrals
Oct 7, 9	15	The Casimir effect
Oct 16	App. B	Regularization
Oct 21	16	Vacuum Polarization
Oct 28, 30	17	The anomalous magnetic moment
Oct 21, 23		Fall Break – No Class
Nov 4, 6	18	Mass renormalization
Nov 11	19	Renormalized Perturbation Theory
Nov 18, 20	20	Infrared divergences
Nov 25	21	Renormalizability
Nov 27, Dec 2	23	The renormalization group
Dec 4	22	Non-renormalizable theories
Dec 6	Final class	Review

Mental Health:

Taking classes at university can be difficult and stressful. If you are struggling with your mental health, please do not hesitate to reach out. I can direct you to resources that might help. Remember that Carleton also offers an array of mental health and well-being resources, which can be found [here](#).

Grade Definition:

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	A = 85-89	A- = 80-84
B+ = 77-79	B = 73-76	B- = 70-72
C+ = 67-69	C = 63-66	C- = 60-62
D+ = 57-59	D = 53-56	D- = 50-52
F < 50	WDN = Withdrawn from the course	
ABS = Student absent from final exam	DEF = Deferred	

Academic Accommodations, Regulations, Plagiarism, Etc.

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances, are outlined on the [Academic Accommodations website](#).

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, [here](#).

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 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. For more details, visit the Paul Menton Centre [website](#).

Addressing Human Rights Concerns

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](#) at equity@carleton.ca.

Religious Obligations

Please contact me 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, please review the [Student Guide to Academic Accommodation](#).

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 where 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: <https://carleton.ca/sexual-violence-support/>.

Accommodations for Missed Work

If you need a short term (5 days or less) accommodation on assignments due to illness or similar reasons, please contact me via email. If you require accommodations that are longer than the 5 days period, please email me to discuss how/whether accommodation needs could be met.

For Pregnancy

Please contact me 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, please review the [Student Guide to Academic Accommodation](#).

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 me 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, see the [Senate Policy on Accommodation for Student Activities](#).

Academic Integrity

Academic misconduct undermines the values of honesty, trust, respect, fairness, and responsibility that we expect in this class. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity. (adapted from Carleton University's Academic Integrity Policy, 2021). Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams

The use of AI sources such as ChatGPT is allowed, but students must *explicitly cite* the use of

such tools. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students. For more information, please see [Carleton's academic integrity page](#).

Course Copyright

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s). Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

Assistance for Students

[Academic and Career Development Services](#)

[Writing Services](#)

[Peer Assisted Study Sessions \(PASS\)](#)

[Science Student Success Centre](#)

Important Dates:

<https://calendar.carleton.ca/academicyear/>

<https://carleton.ca/registrar/registration/dates/academic-dates/>