

Carleton University Physics Department  
PHYS 6701 - Quantum Field Theory (Fall 2021)  
Course Outline

**Instructor:** Prof. Daniel Stolarski (he/him)

**Email:** stolar@physics.carleton.ca

**Lecture Schedule:** Tuesdays & Thursdays, 10:05 AM - 11:25 AM, St. Patrick's Building 100.

This is an in person course, students are expected to attend lectures in person. The classroom does have HyFlex capabilities, and if you are not able to attend lectures for whatever reason, it may be possible to accommodate remote attendance in lectures. Please email me as soon as possible if such an accommodation is needed.

Lectures in this course may be recorded and made available only to those within the class. Sessions are recorded to enable access to students with internet connectivity problems, who are based in different time zone, and/or who have conflicting commitments. Please note that recordings are protected by copyright. The recordings are for your own educational use, and you are not permitted to publish to third party sites, such as social media sites and course materials sites. **If you have concerns about being recorded, please email me.**

**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](#)

**Teaching Assistant:** Dylan Linthorne (he/him) DylanLinthorne@cmail.carleton.ca.

**Student Hours<sup>1</sup>:** Dylan will have virtual office hours on Mondays from 1-2 PM on zoom. Prof. Stolarski's office hours are by email appointment. You can ask either Dylan or Prof. Stolarski questions about the material or assignment problems, but for questions about assignment marking, please contact Dylan.

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<sup>1</sup>Formerly called office hours, likely no longer in an office.

## 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.

## 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 9	6	LSZ Reduction Formula
Sep 14, 16	8	Gauge Invariance
Sep 21	8	The Photon
Sep 23, 28, 30	14	Path Integrals
Oct 5	15	The Casimir effect
Oct 7	App. B	Regularization
Oct 12	16	Vacuum Polarization
Oct 14	17	The anomalous magnetic moment
Oct 19, 21	18	Mass renormalization
Oct 26, 28		Fall Break – <b>No Class</b>
Nov 2, 4	19	Renormalized Perturbation Theory
Nov 9, 11	20	Infrared divergences
Nov 16	21	Renormalizability
Nov 18, 23, 25	23	The renormalization group
Nov 30, Dec 2, 7	22	Non-renormalizable theories
Dec 9	Final class	Review

### **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](#).

### **COVID-19 and the Classroom**

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g. wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and [mandatory self-screening](#) prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the [mandatory symptom reporting tool](#). For purposes of contact tracing, attendance will be taken in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the [COVID-19 website](#).

All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g. directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

For the most recent information about Carleton's COVID-19 response and required measures, please see the [University's COVID-19 webpage](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact [covidinfo@carleton.ca](mailto:covidinfo@carleton.ca)

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the [Student Rights and Responsibilities Policy](#). Failure to comply with Carleton's COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.

**Note about COVID-19 and Mental Health:** The global pandemic has led to extra stress and uncertainty for everyone, and while we may all be experiencing the same storm, this does not mean that we are all in the same boat! If you are struggling, 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 University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals. Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University. More information can be found [here](#).

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](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. 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](mailto: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**

Carleton recognizes that these are unprecedented times during the COVID-19 pandemic, and that students may be experiencing greater stress and other life factors that are not in their control. As a result, Carleton has put into place a protocol for students to apply for accommodations using a self-declaration form in the event of missed work. The form can be found at: <https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf>

### **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

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 \(PASS\)](#)

[Math Tutorial Centre](#)

[Science Student Success Centre](#)

### **Important Dates:**

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

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