

Carleton University Physics Department
PHYS 5702 - Relativistic Quantum Mechanics (Winter 2021)
Course Outline

Instructor: Prof. Daniel Stolarski
Email: stolar@physics.carleton.ca

Lecture Schedule: Mondays & Wednesday, 2:35 P.M. - 3:55 P.M.

This is an online course with synchronous meetings. This means students need to be prepared to meet online via Big Blue Button at the scheduled days and times. Students are expected to remain up to date with the deadlines and due dates provided. This course requires reliable high-speed Internet access and a computer (ideally with a webcam), and a headset with a microphone. If there are issues with equipment, please email as soon as possible.

Web conferencing sessions in this course will 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. If students wish not to be recorded, they need to leave the camera and microphone turned off. You will be notified at the start of the session when the recording will start. Please note that recordings are protected by copyright. The recordings are for your own educational use, but you are not permitted to publish to third party sites, such as social media sites and course materials sites. You may be expected to use the video and/or audio and/or chat during web conferencing sessions for participation and collaboration. **If you have concerns about being recorded, please email me.**

Course Calendar Description: Relativistic wave equations. Expansion of S matrix in Feynman perturbation series. Feynman rules. An introduction to quantum electrodynamics with some second quantization. Gauge theories. May include introduction to Standard Model.

Prerequisites: PHYS 5701.

Required Textbook: Michael E. Peskin and Daniel V. Schroeder, "An Introduction to Quantum Field Theory" Reading, USA: Addison-Wesley (1995).

Course webpage: See CULearn.

Teaching Assistant: Dylan Linthorne (DylanLinthorne@email.carleton.ca)

Office Hours: Dylan will have virtual office hours on Mondays from 10 - 11 AM. 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.

Assignments and Grading

Homework Assignments: 50%

Assignments will be posted on CULearn, with the due date and time noted there. Please scan and submit your solutions via cuLearn 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.

Late assignments will not be accepted without a legitimate reason, such as illness.

Assignment Presentation: 10%

Each student will present to the class one assignment solutions after they have completed the assignments. You will know when your presentations will be, but you may not be told which problem you will be asked to present. You will be marked based on the clarity of your solution as well as on how you answer questions from your peers.

Final Exam: 40%

There will be a take home final exam at the end of the semester. Students will be given 48 hours 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	Topic Description
Jan 11		Review of Special Relativity
Jan 13	2.2	Review of classical field theory and quantum mechanics
Jan 18 & 20	2.3, 2.4	The Klein-Gordon Field
Jan 25 & 27	4.2, 4.3	Correlation Functions
Feb 1	4.4	Feynman diagrams
Feb 3 & 8	4.5	The S -Matrix
Feb 10	4.6	Computing S Matrix elements
Feb 12		ϕ^4 Theory
Feb 15 & 17	Winter Break	No classes.
Feb 22	3.1	The Lorentz Group
Feb 24	3.2, 3.3	The Dirac Equation
Mar 1	3.5	Quantization of the Dirac Field
Mar 3 & 8	3.4, 3.6	Dirac Matrices and Discrete Symmetries
Mar 10 & 15	4.7, 4.8	Feynman rules for Fermions and QED
Mar 17 & 22	5.1–5.3	$e^+e^- \rightarrow \mu^+\mu^-$
Mar 24 & 29	5.4, 5.5	Other QED processes
Mar 31 & Apr 5 & 7		Special topics (spontaneous symmetry breaking, chiral Lagrangian, gauge theories, flavour physics...)
Apr 12	Final class	Review

University policies

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	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52
F = <50			

WDN = Withdrawn from the course

ABS = Student absent from final exam

DEF = Deferred

Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

Academic Regulations, Accommodations, Plagiarism, Etc.:

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:

<http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

Academic Integrity

The University Senate defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This can include:

- reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source;
- submitting a take-home examination, essay, laboratory report or other assignment written, in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, or paraphrased material, concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another’s data or research findings;
- failing to acknowledge sources through the use of proper citations when using another’s works and/or failing to use quotation marks;
- handing in “substantially the same piece of work for academic credit more than once without prior written permission of the course instructor in which the submission occurs.”

Plagiarism is a serious offence that cannot be resolved directly by the course’s instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized.

Penalties for plagiarism:

First offence: A grade of F in the course.

Second offence: A grade of F in the course and a one-term suspension from studies.

Third offence: Expulsion from the University.

Note: While these are the standard penalties, more severe penalties may be applied when warranted.

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).

Academic Accommodations

Text from <https://students.carleton.ca/course-outline/>

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.

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

<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

<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 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 <https://carleton.ca/pmc>

- The deadlines for contacting the Paul Menton Centre regarding accommodation for final exams for the Fall exam period is **November 13, 2020** and for the Winter exam period is **March 12, 2021**.

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>

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. For more details, see the policy at <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

Assistance for Students:

Career Services: <https://carleton.ca/career/>

Academic Advising: <https://carleton.ca/academicadvising/>

Co-operative Education: <https://carleton.ca/co-op/>

Centre for Student Academic Support: <https://carleton.ca/csas/>

Writing Services: <https://www.carleton.ca/csas/writing-services/>

Peer Assisted Study Sessions (PASS): <https://carleton.ca/csas/group-support/pass/>

Math Tutorial Centre: <https://carleton.ca/math/math-tutorial-centre/>

Science Student Success Centre: <https://sssc.carleton.ca/>

Freedom of Information and Protection of Privacy:

Carleton University is committed to protecting the privacy of those who study or work here (currently and formerly). To that end, Carleton's Privacy Office seeks to encourage the implementation of the privacy provisions of Ontario's *Freedom of Information and Protection of Privacy Act* (FIPPA) within the university.

In accordance with FIPPA, please ensure all email communication with staff/faculty is via your Carleton email account. To get your Carleton email you will need to activate your MyCarletonOne account through Carleton Central. Once you have activated your MyCarletonOne account, log into the MyCarleton Portal.

Important Dates:

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

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