

# Course Outline

PHYS 5702: Relativistic Quantum Mechanics (Winter 2023)  
Department of Physics, Carleton University

## General information:

**Instructor:** Yue Zhang, Assistant Professor of Physics

**Office:** 3324 Herzberg Laboratories

**Email:** Yue.Zhang13@carleton.ca Please include "PHYS5702" in subject line.

**Class date/time:** 4:05 – 5:25 PM, Mondays and Wednesdays

**Special note:** I will be away for conference during the week of January 9th. Thus, lectures on January 9th and 11th will not be held. I will find other times during the semester for the make-up lectures.

**First day of class:** January 16th, 2023

**Last day of class:** April 10th, 2023

**Class location:** University Centre Room 280

**Office hour:** Please make appointment by email.

## Course Information:

**Course description:** Relativistic wave equations. Expansion of S matrix in Feynman perturbation series. Feynman rules. An introduction to quantum electro-dynamics with some second quantization. Gauge theories. May include introduction to Standard Model.

**Prerequisites:** PHYS 5701 and permission of the Department.

### Course web page:

Lecture notes and homework assignments will be posted in Brightspace, to log in, go to <https://brightspace.carleton.ca/>. Please check it on a regular basis. Additional email communications will take place as needed.

### Useful textbooks:

- ▶ For most of this course I will follow this book: *An Introduction to Quantum Field Theory*, by M. E. Peskin and D. V. Schroder, Westview Press, (1995);
- ▶ *Quantum Field Theory and the Standard Model*, by Matthew D. Schwartz, Cambridge University Press, (2013);

▶ *The Quantum Theory of Fields, Volume 1: Foundations*, by Steven Weinberg, Cambridge University Press (2013).

### **Topics to be Covered:**

- ▶ Reviews: special relativity, classical field theory, quantum mechanics.
- ▶ Quantization of scalar, fermion and vector fields.
- ▶ S-matrix, Feynman rules, and perturbation theory.
- ▶ Decay rate and scattering cross section.
- ▶ QED processes.

### **Evaluation:**

#### Homework assignments (60%):

Homework assignments will be posted on Brightspace. The deadline for handing in your work is usually two weeks after they have been given out. You are encouraged to discuss together on the homework assignments; however, the work you hand in must be your own.

#### 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.

### **Important Dates:**

January 9, 2023: Winter term begins. First Day of Class.

February 20, 2023: Statutory holiday. University closed.

February 20-24, 2023: Winter break, no classes.

March 15, 2023 : Last day for academic withdrawal from winter courses.

April 7, 2023: Statutory holiday. University closed.

April 12, 2023: Last Day of Class. Classes follow a Friday schedule.

April 12, 2023: Winter term ends.

April 15-27, 2023: Final examinations in full winter, late winter, and fall/winter courses will be held. Examinations are normally held all seven days of the week.

### **Academic-Accommodation**

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

#### **Pregnancy-Obligation:**

Write to 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 accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form [click here](#).

#### **Religious-Obligation:**

Write to 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 [click here](#).

#### **Academic-Accommodations for Students with Disabilities:**

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and 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 me to ensure accommodation arrangements are made. Please consult the [PMC website](#) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

#### **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/equity/sexual-assault-support-services>

#### **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 will be provided to students who compete or perform at the national or international level. Write to 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: <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

## **UNIVERSITY POLICY**

**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**

### **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 exam

Sanctions for not abiding by Carleton's Academic Integrity Policy

A student who has not adhered to Carleton's Academic Integrity Policy may be subject to one of several sanctions:

1. If you take full responsibility for your actions, and it is the first time you have violated the policy, you will receive zero on the assessment. If you are found to have violated the policy but do not take responsibility, an additional grade deduction will be applied (e.g. an A- will become a B+)
2. Subsequent violations of the policy may result in more severe sanctions such as failing the course, suspension from all studies and/or expulsion.

Process of an Academic Misconduct Investigation

Step 1: The instructor believes misconduct has occurred and submits documentation to the Dean of the Faculty of Science.

Step 2: The Dean reviews documentation and can proceed with or dismiss the allegation.

Step 3: If sufficient evidence, the student receives an allegation statement by email. Ombuds services is copied on the email.

Step 4: The student provides a written response to the evidence provided.

Step 5: Either party may request a meeting between student, dean, and the ombudsperson.

Step 6: Dean informs the student of the decision.

Appeal: Student has the right to appeal the decision.

Additional details about this process can be found on the Faculty of Science Academic Integrity website. 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.

### **Plagiarism**

Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, refer the Faculty of Science Academic Integrity website. To

further understand Academic Integrity, consider attending the Learning and Support Academic Integrity Workshop. Summer 2022 14

What are the Penalties for Plagiarism? A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from fulltime studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

### **What are the Procedures?**

3. All allegations of plagiarism are reported to the Dean of Faculty of Science. Documentation is prepared by instructors and/or departmental chairs.
4. The Dean writes to the student and the University Ombudsperson about the alleged plagiarism.
5. The Dean reviews the allegation. If it is not resolved at this level then it is referred to a tribunal appointed by the Senate.

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.

<https://carleton.ca/registrar/academic-integrity/>

### **Assistance for Students**

Academic and Career Development Services: <https://students.carleton.ca/departments/career-services/>

Writing Services: <http://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/>

### **Special Information for Pandemic Measures**

Carleton will continue to follow all public health guidelines as the COVID-19 pandemic continues. Instructors may find it helpful to review the [guidelines for in-class teaching](#) and [labs](#). Both guideline documents are available on the [COVID-19 website](#).

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

**Feeling sick?** Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

**Masks:** Carleton has paused the [COVID-19 Mask Policy](#), but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

**Vaccines:** Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of

vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact [covidinfo@carleton.ca](mailto:covidinfo@carleton.ca).

### **Important Dates for 2022-23**

A [full list of important dates](#) is available on the Calendar website. Please note that the academic withdrawal dates have changed recently. Consult the Calendar website for the most updated information: <https://calendar.carleton.ca/academicyear>