

COURSE OUTLINE – PHYS 4602/5602

Particle Physics – Winter 2021

Professor: Simon Viel

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Please include “PHYS4602” or “PHYS5602” in subject line.

Teaching assistant: Hassan Easa

Office hours: TBD

Class time: Mondays and Wednesdays, 4:05 – 5:25 pm

Class location: Online. A link to the classroom will be provided on CULearn.

First day of class: Monday January 11, 2021

Official course description: Standard Model. Properties of leptons, quarks, hadrons. Fundamental interactions: photon, gluons, W/Z bosons. Higgs boson. Conservation laws, invariance principles, quantum numbers. Decay rates and scattering cross-sections. Quantum electrodynamics and chromodynamics. Resonances. Weak interactions, CKM matrix, parity and CP violation. Neutrino masses and oscillations. Future directions.

Prerequisites: PHYS 4707 or permission of the Department.

Required textbook: *Introduction to Elementary Particles (2nd, revised edition)*, by David Griffiths.
This textbook is available at the Bookstore (Univ. Centre)

Communication policy: Students are responsible for reading and responding to information distributed through the CULearn course page. Please make sure to check the course page regularly! For questions about course content and assignments, please try using the CULearn Forum tool. All online communications should respect “Netiquette”: <https://carleton.ca/online/online-learning-resources/netiquette/>
Additional email communications will take place as needed.

Evaluation: Assignments (50%)
Midterm Exam: Wednesday February 10, 2021 (20%)
Final Exam: During formal final exams period (30%)

Course Timeline (Tentative):

Before the first class on each topic, please read the corresponding chapters indicated.

* indicates tentative homework assignment hand-out dates (due Wednesday the next week)

<i>Class dates</i>	<i>Textbook chapters</i>	<i>Topics</i>
January 11, 13	Chapters 1, 2	Course Introduction, Overview of Particle Physics
January 18, 20*	Chapter 3	Relativistic Kinematics
January 25, 27*, February 1	Chapters 4, 5	Symmetries, Conservation Laws, Bound States
February 3	Sections 6.1 – 6.2	Decays and Scattering
February 8	Section 6.3	Feynman Calculus
February 10	-	Midterm Exam
February 15-19	-	Reading Week
February 22	-	Higgs Bosons
February 24* March 1, 3*, 8	Chapter 7 Sections 8.1 – 8.2	Intro to Quantum Electrodynamics: Charged Leptons, Photons Electrodynamics of Quarks, Resonances
March 10*, 15	Sections 8.3 – 8.6	Intro to Quantum Chromodynamics: Quarks and Gluons
March 17*, 22, 24*	Chapter 9	Weak Interactions: W and Z Bosons, Three-Body Decays
March 29	Chapter 10	Standard Model of Particle Physics, Electroweak Symmetry Breaking
March 31*, April 7 <i>[no class April 5]</i>	Chapter 11	Neutrino Masses and Oscillations
April 12	Sections 12.2 – 12.6	Future Directions
April 16-27 (TBD)	-	Final Exam

Evaluation:

Requirements for Undergraduate and Graduate Students

This course is offered at the undergraduate and graduate level, with different requirements. In particular, additional questions may be assigned to graduate students on homework assignments and exams.

Assignments (50%)

Written homework problems will be assigned on eight Wednesdays during the term, and they will be **due at the beginning of class** on Wednesday the week after they were assigned. Late assignments will not be accepted, unless permission is received from the professor for documented reasons (illness, injury or other extraordinary circumstances beyond the student's control).

For more information, please see Section 4.4 of the Academic Regulations of the University: <http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

You are encouraged to study together, and write separately. **The work you hand in must be your own.** Replicated / copied homework assignments will receive a grade of zero. Each student's homework assignment with the lowest percentage grade (except for disciplinary reasons) will not be considered when calculating the contribution of homework assignments to the final grade.

Midterm Exam (20%)

The midterm exam will be given during the regular class period, Wednesday February 10. The midterm exam will be open book and open notes.

For this exam it is forbidden to: use unauthorized aids, look up any information online, consult with any other person, or share exam content with anyone.

Missed midterm exam: If you miss the midterm exam, you must notify the professor within three working days after the date of the exam. A deferred midterm exam will usually be permitted for documented reasons (illness, injury or other extraordinary circumstances beyond the student's control). For more information, please see Section 4.4 of the Academic Regulations of the University: <http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

If a deferred midterm exam is not granted or possible, then the midterm exam will receive a percentage grade equal to that of the final exam. The final exam is expected to be harder than the midterm exam, so please do not rely on this!

Final Exam (30%)

The final exam will be 3 hours long, given during the final examination period in April. The final exam will be open book and open notes.

For this exam it is forbidden to: use unauthorized aids, look up any information online, consult with any other person, or share exam content with anyone.

Missed final exam: The final exam is a requirement to successfully complete this course. In accordance with Section 4.3.1 of the Academic Regulations of the University:
<http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

Students who are unable to write the final exam because of a serious illness/emergency or other circumstances beyond their control may apply for accommodation. Normally, the accommodation for a missed final exam will be granting the student the opportunity to write a deferred exam. In specific cases when it is not possible to offer a deferred exam, and with the approval of the Dean, an alternate accommodation may be made.

The application for a final exam deferral must:

1. be made in writing to the Registrar's Office no later than three working days after the original final exam; and,
2. be fully supported by appropriate documentation and, in cases of illness, by a medical certificate dated no later than one working day after the final exam, or by appropriate documents in other cases. Medical documents must specify the date of the onset of the illness, the (expected) date of recovery, and the extent to which the student was/is incapacitated during the time of the examination. The University's preferred medical form can be found at the Registrar's Office.

Students will not be given a deferral of a deferred final exam.

Synchronous Course:

This course is a real-time, online course where the instructor and students meet via web conferencing tools, at scheduled days and times. Instructors and students share information, ideas and learning experiences in a virtual course environment.

Participation in synchronous courses requires students to have reliable high-speed internet access, a computer, and a headset with a microphone.

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

FND = (Failed, no Deferred) = student could not pass even with 100% on final exam

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 are not trivial. They can include a final grade of “F” for the course.

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 please 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/>