SYLLABUS
PHZ 4390, Introduction to Particle Physics, Fall Term 2022

Instructor: Sergey Klimenko, Klimenko@phys.ufl.edu, 352-514-8225
Class lectures: in MCCB 3124 on Tuesdays(T, period 5-6) and Thursdays(R, period 6)
Office Hours: in person or Zoom, Tuesdays 2-3pm and Thursdays 2-3pm

Synopsis: This one semester course at the undergraduate level is designed to introduce the field of particle physics, including the history, concepts, experimental techniques, and general overview of the fundamental theories that comprise the Standard Model of particle physics.

Purpose of the course: The purpose of this course is to provide students with a foundation in the concepts, fundamental principles, and experimental methods used in modern particle physics. Examples include kinematics in special relativity, relativistic collisions, interaction of particles with matter, particle reactions and decays, principles of operation of modern detectors and the current state-of-the-art instrumentation for high energy and astroparticle physics.

Prerequisites: Introductory physics with calculus (PHY2048/9 or equivalent) and modern physics (PHY3101 or PHY3063), with Quantum Mechanics 1 (PHY4604)

Required textbook:
-Particle Physics, B.R. Martin & G.Shaw, 4th edition, John Wiley &Sons
Additional Resources:
- Detailed lecture notes will be made available through the Canvas system.
-Introduction to elementary particle physics, A. Bettini, 2nd edition, Cambridge University Press
-Particle Physics in the LHC Era, G. Barr, R. Devenish, R. Walczak, T. Weinberg, first edition, Oxford University Press
-The Experimental Foundation of Particle Physics, R. Cahn and G. Goldhaber, 2nd edition, Cambridge University Press
- Particle Detectors. C. Grupen & B. Shwartz, second edition, Cambridge University Press

PHZ 4390 web page is http://www.phys.ufl.edu/courses/phz4390/fall22/ This web page contains information relevant for the class. There you will find the homework assignments, exam schedule and the class diary. Please, check for updates regularly, especially if you miss a class.

Homework: There will be graded homework (HW) assignments during the semester (one HW every ~2 weeks). Homework assignments and due dates, subject to change, will be available via the [Homework] link on the left panel of the course web page. Homework will be collected in the Canvas before the due date. Students will need to upload their homework as a single file in pdf format to the corresponding HW assignment. ***Late HWs will be accepted outside of the Canvas and graded at -50% of the score. Homework that are overdue by more than one week will not be graded***. Make your solutions neat, concise, and intelligible. It is not sufficient just to state the answer. Points may be deducted, if it is difficult to find and/or understand the solutions. T**here will be no make-up homework. Instead, the lowest homework score will be dropped at the end of the semester**. The graded HWs will be worth 40% of the total grade (see the grading policy below).

Exams: There will be two exams: one in the middle of the semester and one in the end. The second exam includes the paper reading project and presentation given by students in class. The exams will contribute 25% each toward the final grade.

Quizzes: There will be class quizzes throughout the semester. The quizzes will not be announced in advance. Each quiz will last no more than 10 min and will be administered at the beginning or the end of the lecture. There will be no make-up quizzes, but one lowest quiz score will be dropped. The lowest score is 0 for missed quizzes and 1-4 for taken quizzes. The quizzes will contribute a total of 10% toward the final grade.

Grading procedure: All assignments will be graded within a few days after the due date, exams are graded the next day. The graded assignments will be uploaded to Canvas and grading scores entered to Canvas for student's review. All questions regarding graded work should be sent to klimenk0@phys.ufl.edu or asked in person during the office hours.

Grading policy: Each graded assignment (quiz, homework or exam) has a maximum score - the total sum of scores of all examinable problems in the assignment. In addition to the examinable problems, assignments may have bonus questions, which do not contribute to the maximum score, but are accounted for in the total score gained by a student. Because of the bonus questions it is possible that the total score could be greater than the maximum score. The ratios of these two scores from all assignments are used to calculate the final percentage score. Your final grades will be based on the total sum of the percentage scores for quizzes, homeworks and exams, and defined by the following grading table:

grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
score	90%	85%	80%	75%	65%	60%	50%	40%	35%	35%	35%	30%

The corresponding grades are assigned at or above the score threshold shown in the table. These thresholds may be lowered, depending upon numerous factors, but will not be raised.

For additional details regarding grading policies, please, see the university website: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Requirements for class attendance and make-up exams are consistent with the university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/

UF students are bound by The Honor Pledge which states "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. The Honor Code can be found here: https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/

Office of Academic Support: offers free one-on-one and small group tutoring sessions to all UF students interested. The tutors are proficient in a broad range of topics, including economics, mathematics, statistics, writing, accounting, Spanish and the physical and biological sciences. OAS tutors go through a rigorous selection process and receive training so that they are prepared to answer questions. Remember these tutoring services are offered at no additional cost to all UF students. Contact information: https://oas.aa.ufl.edu/services/

Student Life Success Services: Enhancing student success through learning and engagement - check out this web page:
https://www.ufl.edu/student-life/success-services/
and contact their academic advisors:
http://www.ufadvising.ufl.edu/college-remote-advising-contacts/

Counseling and Wellness Center: Contact information for the Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc/Default.aspx (392-1575), and the UF Police Department: 392-1111 or 911 for emergencies.

Physics is practiced and advanced by a scientific community of individuals with diverse backgrounds and identities and is open and welcoming to everyone. The instructional team recognizes the value in diversity, equity and inclusion in all aspects of this course. This includes, but is not limited to differences in race, ethnicity, gender identity, gender expression, sexual orientation, age, socioeconomic status, religion and disability. Students may have opportunities to work together in this course. We expect respectful student collaborations such as attentive listening and responding to the contributions of all teammates. Physics, like all human endeavors, is something that is learned. Our aim is to foster an atmosphere of learning that is based on inclusion, transparency and respect for all participants. We acknowledge the different needs and perspectives we bring to our common learning space and strive to provide everyone with equal access. All students meeting the course prerequisites belong here and are well positioned for success.

G – Griffith textbook

TS-Tavernier textbook (2010)

Weekly schedule:

This course does not provide systematic study of QM, QFT, QED, QCD and SM

Week01(Aug.23-Aug.27): Introduction, natural units, particle physics overview

Week02(Aug.31-Sep.03): Relativistic kinematics, Relativistic collisions, reactions, invariant mass, threshold energy

Examples: pi->mu+nu, pi0->gg, impossibility of e-e+g, Discovery of antiproton, cosmic rays(GZK at Avery note),

Week03(Sep.08-Sep.10): QM basics, Relativistic wave equations

Week04(Sep.13-Sep.17): Decays. Fermi Golden rule (G.195). Particle interactions, Feynman diagrams

Examples:

Week05(Sep.20-Sep.24): Cross-section

Week06(Sep 27-Oct.01): accelerators, colliding experiments, luminosity (TS is quite good)

Week07(Oct.04-Oct.06): Interaction of particles with matter

Week08(Oct.11-Oct.13): Detectors, colliding experiments, neutrino experiments, cosmic rays

Week09(Oct.18-Oct.22): Discovery of the electron, photon (G.14-16), muon, pion

Week10(Oct.25-Oct.29): Radioactivity, beta decay

Week11(Nov01-Nov05): Strange particles, CP violation

Week12(Nov08-Nov12): Strange particles, CP violation

Week13(Nov15-Nov22):

Week14(Nov29-Dec.03):

Communication and interaction expectations.

Phy3221 is an online synchronous course delivered via Zoom meetings starting on August 31, every Monday, Wednesday and Friday at 12:40-1:30pm, excluding holidays – check out the course schedule Students will need to run zoom on one of suitable devices: computer, tablet or phone with access to the internet. Students will be able to view all lecture material via shared screen and listen to lectures over audio channel. All lectures will be recorded and available from zoom cite or Canvas after classes. Lecture notes will be posted on canvas with links in the course schedule. During lectures students will have the opportunity to ask and answer questions. In addition, twice a week, there will be Zoom Office Hours: Tuesdays 2-3pm and Fridays 4-5pm. All assignments will be posted in Canvas with specified start and end date and time. Quizzes and exams will be proctored by Honorlock. For each assignment students should compile their work in a single pdf file and upload this file to the corresponding Canvas portal. All grade scores will be stored in Canvas.

Technologies that will be used in the course.

Phy3221 synchronous course heavily relies on Canvas and Zoom. Students will need to run a zoom app on one of suitable devices: computer, tablet or phone with access to the internet. Students will be able to view all lecture material via shared screen and listen to lectures over audio channel. All lectures will be recorded and available from zoom cite or Canvas after classes. Quizzes and exams will be proctored by Honorlock. For each assignment students should compile their work in a single pdf file and upload this file to the corresponding Canvas portal. For preparation of graded work it is recommended to use a tablet and graphic pen together with a suitable note taking application (for example Good Notes 5) which allows to save notes in pdf format. Also, students may use a usual pen and white paper to do the course assignments, scan multiple paper sheets into a single pdf file and upload it to Canvas.

Provide learners with information on protecting their data and privacy for tools introduced or recommended throughout the course.

Canvas is used to keep track of all personal data, graded work and grades. Scheduled course zoom meetings are protected by password.

How to find academic or student services support.

how the course materials help students to complete courses activities and achieve the course learning objectives.

how each activity or assignment is related to the course objectives and how submitted work is evaluated.

- Lectures give detail and interactive explanation of the text-book material, explanation of main concepts, their relations to each other, description of real world and step-by-step application of these concepts to solve problems. The goal of lectures is not to memorize material but to develop critical thinking, which is crucial in understanding of main concepts and their applications for solving problems.
- Lecture notes keep track of the discussion topics and put the text-book material in the context of specific problems discussed in class
- Quizzes provide quick assessment of topics missed by students and common mistakes
- Homework is the main tool to master math skills and logical reasoning.
- Exams give students an opportunity to test their knowledge and demonstrate that they can think clearly, rationally and can make logical connections between different ideas to solve problems. Both exams and homework do not use multiple choice problems.

All submitted work is evaluated not just to get a grade, but to help students to understand their mistakes in use and application of basic concepts and logical reasoning. Usually there is no penalty for typos and small mistakes and students get almost full credit if they demonstrate understanding of the problem and provide conceptually correct solutions.

Its methods and ideas are crucially important, as they form the basis of all other branches of theoretical physics, including quantum mechanics, statistical physics, and field theory. Such concepts as the Lagrangian and Hamiltonian formalisms, normal oscillations, adiabatic invariants, Liouville theorem, and canonical transformations lay the foundation, without which any further in-depth study of theoretical physics is impossible.

1. Demonstrate an intermediate knowledge of Newton's Laws. DLO 1 2. Demonstrate a basic knowledge of equations of motion. DLO 1, 2 3. Apply advanced Newtonian methods to complex motion problems. DLO 1, 2 4. Demonstrate an intermediate knowledge of oscillatory motion. DLO 1, 2 5. Describe and model the oscillations of damped and undamped systems. DLO 1, 2 6. Demonstrate a basic knowledge of Calculus of Variations. DLO 1 7. Demonstrate a basic knowledge of Lagrangian & Hamiltonian dynamics. DLO 1 8. Apply Lagrangian & Hamiltonian methods to complex motion problems. DLO 1, 2 9. Demonstrate an intermediate knowledge of central-force motion. DLO 1, 2 10. Apply advanced methods to complex central-force motion problems. DLO 1, 2 11. Generate solutions to mathematical problems using current data analysis software (Mathcad). DLO 2, 4 12. Apply the fundamental processes of investigation, modeling and analysis DLO 2, 3

This is an upper level college physics course that emphasizes a systematic approach to the mathematical formulation of mechanics problems and to the physical interpretation of the solutions. Fundamental concepts and principles in classical mechanics will be applied to particles, systems of articles and rigid bodies. The mathematical framework developed in this course will consist of advanced mathematical and numerical techniques that will provide a solid mathematical background used in all modern physics.

Mechanics 1

Sergey Klimenko

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course web page

Welcome to Mechanics 1 - the first course of the two-semester sequence in undergraduate level classical mechanics. This is an online synchronous course delivered via Zoom meetings starting on August 31, every Monday, Wednesday and Friday at 12:40-1:30pm. Check out the Course Description below, and particularly the **main course web page** -- the collections of useful links you will use during the semester. The course page also lists the required books and technologies; you'll need these beginning August 31st. The course policies are described in **syllabus**, including description of the course assignments and grading policy. You could keep track of classes in the **course schedule** -- it lists all course assignments, important due dates and has links to the course notes. While the exam dates and the assignment due dates are unlikely to change, please, note that the **course schedule** is a living document, which is updated to accommodate for possible schedule changes during the semester. All sensitive information (graded work, grade scores, etc) will be stored in Canvas, which will also be used for online exams and quizzes with the Honorlock proctoring. Links to all scheduled zoom meetings will be available via Canvas Calendar.

Course Description: This course lays out the foundation for students to understand the mathematical formulation of Newton's mechanics. Starting with the basic concepts introduced by Galileo and Newton, the course gives a deeper understanding of these concepts and introduces a more advanced formulation of mechanics developed by Lagrange and Hamilton. The Lagrangian and Hamiltonian mechanics gives deeper insights of conservation laws in physics, mechanics of non-inertial frames, motion of complex systems and form the basis of other branches of theoretical physics, including quantum mechanics, statistical physics, and field theory. This course requires more advanced mathematical skills and logical reasoning going beyond introductory physics courses. The mathematical framework developed in this course - vectors, vector calculus, differential equations, Fourier series, calculus of variation and linear algebra - provide a solid mathematical background used in other branches of science

Course Prerequisites: Introductory physics with calculus PHY 2048 or equivalent. Fluency in algebra, trigonometry and calculus is necessary for your success in Mechanics I. Calculus III will be used extensively throughout the course. Courses in differential equations and linear algebra are recommended.

Course Learning Goals: The goal of the course is to develop a bridge from the introductory course (PHY2048) to the Lagrangian and Hamiltonian formulation of mechanics. At the end of the semester, students will be able to

- demonstrate a knowledge of Newton's Laws
- demonstrate a knowledge of equations of motion
- understand the conservation laws governing physical systems
- apply advanced Newtonian methods to complex motion problems.
- demonstrate an knowledge of oscillatory motion.
- demonstrate a basic knowledge of Calculus of Variations
- demonstrate a basic knowledge of Lagrangian & Hamiltonian mechanics.
- apply Lagrangian & Hamiltonian methods to complex motion problems.

- develop skills for logical analysis of complex problems
- develop a solid mathematical background used in other branches of science