

Physics 100: The First-Year Seminar in Physics and Astronomy

The course is divided into five two-week modules, with five different professors presenting background material in their fields of expertise. We hope to make some connections between the material across these different topics and the professors will be coordinating the grading and logistics of the course. Here's an outline of the course:

1. ***Accelerator-Based Materials Analysis***: We will use a particle accelerator to generate and accelerate a beam of protons which will then bombard a sample of material of unknown composition. From the interaction of the protons with the elements in the sample, x-rays, characteristic of the elements in the sample, will be produced. By collecting a spectrum of these x-rays, we will identify the elements that make up the sample of material. Professor Scott LaBrake labrakes@union.edu
2. ***Exploring the Subatomic***: In 2012, scientists at the Large Hadron Collider (LHC) announced the discovery of the Higgs boson which was the final piece needed to validate the Standard Model of particle physics. The Standard Model is the theory that classifies the fundamental particles and describes how they interact. In this module, we will discuss the standard model and look at the ways current and future experiments around the world test and try to break this theory. Professor Colin Gleason gleasonc@union.edu
3. ***Quantum Mechanics***: Quantum mechanics describes the behavior of microscopic particles-- atoms, molecules, electrons, and light-- and is famously weird. It predicts numerous phenomena that run counter to our everyday intuition: objects passing through obstacles they shouldn't be able to cross, objects in multiple states at the same time, "spooky" correlations between widely separated particles. In this module, we'll discuss the physics behind some recent high-profile experiments that demonstrate these strange results in the real world. Professor Chad Orzel orzec@union.edu
4. ***Molecular Biophysics***: Life is a complex system that is definitely more than the sum of its parts. Cells self-replicate, macromolecules self-assemble, molecular motors translate chemical energy into motion... During the last decades advances in physics have led to further understanding of biological phenomena at the same time as the curiosity about biological phenomena has motivated further advances in physics. In this module we will learn what a biophysical problem looks like and who is a biophysicist. We will focus on how macroscopic functions of life emerge from interactions among the many microscopic constituents. Professor Cecilia Bores Quijano boresquc@union.edu
5. ***Gravitational Waves***: Over 100 years ago Albert Einstein predicted the existence of Gravitational Waves through his theory of General Relativity. But only recently scientists succeeded in measuring these waves using two very large laser interferometers. In June of 2023, four groups using pulsar-timing arrays announced that ripples had been detected with wavelengths as long as a light year. These observations of the merger of two black holes,

which have been verified many times by now, have opened a whole new way of “looking” at our universe. Professor Francis Wilkin wilkinf@union.edu

Reading material will be supplied for each modular topic as will homework assignments. The nature of the homework may vary with the module, but there will be some graded work for each two-week portion of the course. Students are encouraged to work on the assignments together with others in the course. It is expected, however, that the work you hand in to be graded will be written up independently by you after discussions with other students. Please indicate on the homework who you worked with in preparing the assignment.

Each module will also have an associated quiz, lab, or project. Your grade in each module will be based on your performance on the quiz/project and/or homework, and your final grade for the course will be the average of your grades in the five modules. Union College recognizes the need to create an environment of mutual trust as part of its educational mission. Responsible participation in an academic community requires respect for and acknowledgment of the thoughts and work of others, whether expressed in the present or in some distant time and place.

Matriculation at the College is taken to signify implicit agreement with the Academic Honor Code, available at honorcode.union.edu. It is each student’s responsibility to ensure that submitted work is their own and does not involve any form of academic misconduct, which includes unauthorized use of AI technology or tools that have not been explicitly allowed by an instructor. Students are expected to ask their course instructors for clarification regarding, but not limited to, collaboration, citations, and plagiarism. Ignorance is not an excuse for breaching academic integrity. Students are also required to affix the full Honor Code Affirmation, or the following shortened version, on each item of coursework submitted for grading: "I affirm that I have carried out my academic endeavors with full academic honesty." [Signed, Jane Doe]

As a college student, there may be times when personal stressors interfere with your academic performance and/or negatively impact your daily life. If you or someone you know is experiencing mental health challenges at Union College, please contact the Counseling Center located in the Wicker Wellness Center or call 518-388-6120 between the hours of 8:30 A.M. to 5:00 P.M. Counseling services are free and confidential. **In a crisis, or after hours, contact Campus Safety at 518-388-6911. The National Suicide Prevention hotline also offers a 24-hour hotline at 800-273-8255.**