PHYS 1116: Mechanics and Special Relativity (Honors)
Course Syllabus

Logistics

- Instructors: [Professor]
  - [contact info]
  - Office Hours: TBA
- Teaching Assistants: [TA]
  - [contact info]
  - Office Hours: TBA
- Lecture location and time: [Room number, meeting times]
- Discussion location and time: [Room number, meeting times]
- Homework study hall location and time: [Room number, meeting times]

Course Description:

Are you interested in majoring in physics? Do you want to learn more about how the physical world works and the rules that govern it? Have you taken calculus and now want to do something useful with it? If you answered, "yes" to any of the above questions, then this course is for you.

PHYS 1116 is intended for first-year students who are interested in pursuing a major in physics and have a firm background in calculus (recommended prerequisite: MATH 1910 or higher). PHYS 1116 will fulfill all of the same requirements as PHYS 1112, but will be taught at a more abstract level.

"Mechanics" is the name that physicists give to the laws and rules that describe the movements of objects around us. The question of whether one can understand and predict, for example, the motions of stars and planets, dates back millennia. Modern physical science began only in the 17th century, when Isaac Newton postulated the laws of motion that we now use. Newton's significant innovation was a mathematical framework for making testable, empirically verifiable predictions about the movements of everyday objects.

This course will serve as an introduction to mechanics. Additionally, the course will serve as a foundation for other courses in physical science. Concepts from mechanics such as force, energy, and momentum will appear throughout courses in physics and in other mathematical sciences. Taking this course is your first step towards a sophisticated and detailed understanding of the physical world.

Topics covered

- **Interpreting Calculus**
  Calculus was invented for physics – it gives us a mathematical way to describe change. As such, it is very important for you to be familiar with calculus because we will be using it throughout the course. We will begin the course by briefly reviewing how to apply the mathematical tools from in the context of mechanics. (**Kinematics, Derivatives, Optimization, Integrals, Ordinary Differential Equations**)
- **Forces**

If you push or pull on an object, it starts to move. Forces are how we understand interactions between objects, and how those interactions lead to motion. (**Vectors**, **Newton's Laws**)

- **Conservation Laws**
  Energy changes form, but isn't created or destroyed. Similarly, one object can transfer its momentum to another in a collision, but the total amount of momentum stays the same. Both of these are examples of conservation laws, one of the most powerful ideas in physics. (**Energy, Momentum, Angular momentum, Collisions**)
- **Special Relativity**
  What happens when things move really fast, close to the speed of light? We will need to forget everything we have learned in the course and develop a new set of rules that describe the mechanics of objects moving close to the speed of light. (**Time Dilation and Length Contraction, Geometry of Spacetime**)

Course Goals

- You will apply the powerful conceptual tools of physics to solve problems and make predictions about the movements of everyday objects
- You will construct strong arguments that thoroughly explain and verify your solutions on weekly problem sets
- You will collaborate with your peers to discuss and solve physics problems together during lecture and discussion section

Activities

- **Lecture**
  We will work together as a class to develop intuition about the laws of mechanics. Before coming to class, read through the materials provided for you online. (Refer to the Course Schedule to find out exactly what you will need to do to prepare for each class.) Throughout lecture, I will present you with a series of questions for you to think about and discuss with your classmates. Explaining your answers to others is one of the best ways to make sure that you understand something.
- **Discussion Section**
  Applying the physics concepts that we learn in class is a skill. Nobody ever learned a skill just by watching – you have to sit down and practice. This is what discussion section is for. Twice a week, you will work with a small team of classmates to practice applying physics to new situations and problems. Be sure that every member of your team understands your solution, as there will be a quiz on a similar problem. Additionally, participating during discussion will better prepare you for completing homework and test problems. Practicing solving problems during discussion (where there is no penalty for making mistakes) will help you improve your problem solving skills and help you retain them for later in the course as well as afterwards.
- **Homework Write-ups**
  Constructing an argument is as important in science as it is in the humanities. Your homework assignment each week will require you to describe, in complete

sentences, each step of your reasoning for your solution to one or more physics problems. By explaining your assumptions and the physical principles that you use at each step, you will learn how to give a thorough and convincing argument. This is an important skill for this class, as well as for science courses that you may take in the future. For examples of what a strong homework write-up looks like, as well as a grading rubric, refer to [other document].

- **Quizzes**

  Each week, during discussion section, there will be a short quiz on the material covered in lecture, discussion, and the homework. The quiz will very closely resemble the problems that you worked on with your team earlier in the week. We are not going to trick you here – we just want to see how well you work on your own as an individual student. Quizzes can be a helpful diagnostic for you as well – if you find you don't know how to answer a problem on a quiz then you will know what to review for next time.

- **Exams**

  We will have three exams [Dates]. Each exam will mostly focus on material covered in the previous third of the course. Be aware, however, that concepts from the early parts of the course will still appear later in the course – this is unavoidable in a class that builds intuition over time. You will not be allowed to use your notes or your textbook, but we will provide you with an equation sheet so you can avoid memorizing a bunch of formulas. You will not need a calculator for any quiz or exam in this course.

  Think of each exam as a quiz, but bigger–the exam will mostly contain problems similar to ones that you have seen before. There will also be one question that will challenge you to combine many different physics concepts to solve a new type of problem. Again, we are not trying to trick you – we are trying to see how well you work on your own as an individual, as well as challenge you to think a little more deeply about what you've already learned.

Resources

- Books
  - *An Introduction to Mechanics*, 2nd edition – Kleppner and Kolenkow (main textbook)
  - *University Physics*, 13th edition – Young & Freedman (simpler – if K&K doesn't make sense, try reading this first)
  - *Mathematical Methods in the Physical Sciences* – Boas (mathematics reference, contains lots of worked example problems that show how to use math in the context of physics)
- Computing Tools
  - Mathematica and WolframAlpha (free online) – a computer program that can help you check your algebra and create graphs
  - Matlab and Python – programming-based tools for plotting and solving
- Websites
  - Hyperphysics – a good online physics resource, at the level of high school AP physics

  - Mathworld – a good online mathematics resource

Whenever you use a resource outside of our main textbook (K&K), you are expected to cite that resource. For example, if you find a mathematical proof on Mathworld online you should write that you found the proof on Mathworld. You are welcome to write computer programs to help you solve homework problems. If you do, please turn in your code with your homework.

- People
  - Instructors – Feel free to email us at any time if you have questions about the course material.
  - Classmates – Discussing the material with your classmates is the best way to make sure you understand something

On homework assignments, please write the names of all the classmates that you consulted. You are encouraged to discuss and work with other students, as long as the write-up you turn in is entirely your own work: talk to your classmates, but do not copy what they write.

Expectations

Students take PHYS 1116 for many different reasons. Some of you may be intent on majoring in physics, while others of you may simply be using this course to fulfill a science requirement or elective. During the first two weeks of the course (see the Course Schedule, below), you will meet one-on-one with your Discussion Section TA to talk about your personal goals and what you want to take away from this course. This is also an excellent opportunity for you to ask any questions that you have about the course.

Feedback

We (the instructors) welcome feedback from you (the students) – feel free to communicate with us if you feel that something is going wrong in the course. To give some examples: If one section of material was insufficiently explained, let us know. If you're confused about the requirements for one or more assignments unclear, let us know. If office hours or exams are scheduled inconveniently, let us know.

If you do not feel comfortable talking us directly, feel free to use the anonymous feedback forum available online at [online location]. We promise you, any message to us from this channel is completely anonymous, and nobody but the instructors will see your message. We promise to respond promptly to all reasonable requests made through this channel, and will discuss the possibility of adjusting the course accordingly.

Grading Scheme

- Homework write-ups – 30% (lowest homework score dropped)
- Lecture participation (clicker questions) – 15%
- Co-op problems – 15%
- Homework quizzes – 10% (lowest quiz score dropped)
- Prelim 1 – 10%
- Prelim 2 – 10%
- Final exam – 10%

You will not be graded on a curve.

Daniel T Citron
PHYS 1116 Course Syllabus

This Course vs. PHYS 1112

A common question: should I take PHYS 1116 or PHYS 1112? PHYS 1116 covers much of the same material as PHYS 1112. There are a few major differences between the two courses:

- Abstraction – this course taught at a higher level of abstraction and requires familiarity with the tools of calculus than PHYS 1112
- Pace – this course will proceed through the material much faster than PHYS 1112
- Special relativity – this course will provide an introduction to this topic. If you take PHYS 1112, you will still have the opportunity to learn about special relativity by taking a short course later (PHYS 2216)

We recommend that you take a week or two to figure out whether this course is at the right difficulty level. The first problem set and quiz will be intended as a diagnostic to help you decide whether to stay in this class or switch to PHYS 1112. The last date when you are permitted to switch is [date]. Remember: you can still major in physics if you take PHYS 1112 instead of this course.

Students with Disabilities

The course will accommodate students with disabilities or other impairments that interfere with their studies. Please refer to Cornell's Student Disability Services office and consult with me at the beginning of the course.

Academic Integrity

You are expected to adhere to the ethical standards outlined in Cornell University's Code of Academic Integrity.

In lecture and in discussion section you will be discussing and working together in teams. When working on homework or studying for exams I encourage you to continue discussing the material with your peers. That being said, the homework sets that you turn in must represent *your own work* – it is unacceptable for you to copy someone else's homework write-up or pass off another student's work as your own. Similarly, if you use any source outside of our main textbook (K&K) on a homework problem, you must appropriately cite that source. During exams you must not talk to or otherwise confer with your classmates or anyone outside of the exam room.

Any course assignments that contain plagiarized material or otherwise do not meet the standards of the Code of Academic Integrity will be given zero points, and any students responsible may be subject to penalties in accordance with the University Code.

Course schedule

[to be added later, but will include a week-by-week breakdown of reading materials for each class; homework due dates; and exam dates]