Physics 141N: Einstein's Relativity Autumn 2018

Course Information

- Professor: Dr. Andrew Ware
- Office: CHCB 130
- Email: andrew.ware@umontana.edu
- Lectures: MWF 12:00 pm – 12:50 pm in DHC 120
- Office Hours: MW 2 – 3 PM & RF 10 – 11 AM & by appointment
- Course web page: umonline.umt.edu (Moodle)

Course Overview

This course develops one of the most profound concepts in physics, the principle of relativity, and follows it to its surprising and counterintuitive insights into the nature of space and time. Students in this course will acquire a greater appreciation for the power and beauty of theoretical physics. We will begin with a brief historical view of the study of motion including the works of Galileo and Newton. We will explore the necessity of introducing relativity theory to match known experimental results. Einstein's special theory of relativity is introduced from a modern, geometrically oriented perspective, using spacetime diagrams throughout, and emphasizing the deep connection between time and space. We will apply the results of relativity theory to the practical real world problems of high-energy particle physics, where the use of relativity is essential. Throughout the course, we will emphasize the logical structure of relativity to show how the unexpected and counterintuitive consequences of the theory follow directly and inevitably from the principle of relativity:

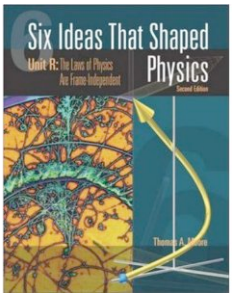
"The laws of physics are the same in all inertial reference frames."

Learning Objectives

My goals in this course are:

- Introduce students to Einstein's special theory of relativity.
- Develop student problem solving skills in relativity.
- Foster interest in and inspire ongoing study of physics.

Required Materials



Six Ideas That Shaped Physics
Unit R: Laws of Physics Are Frame-Independent
By Thomas Moore (2nd or 3rd Edition)
Available at the UM Bookstore for about $50
Additional reading material will be available on the course Moodle page.

iClicker
Radio frequency repsonse remote.
Available at the UM Bookstroe for about $40.

Expectations of the Professor

Physics 141N is an honors course, and offers an intensive learning environment for outstanding undergraduates. This is a challenging course, and by choosing to enroll you are agreeing to work hard and remain on schedule with the readings and assignments. Students should expect daily homework assignments as they build expertise in the material. The University of Montana is one of only a handful of schools around the country offering an introductory course in relativity accessible to students who have not completed one to two years of introductory physics. By the end of the semester, you will be comfortably solving problems in relativistic dynamics and particle physics that are challenging to beginning graduate students!

This course has no prerequisites. I expect only that you have a working knowledge of algebra and trigonometry. A modest exposure to calculus is helpful, but not strictly necessary. I would recommend gaining familiarity with the Greek alphabet, as its use is ubiquitous in physics.

Time in the classroom is an essential part of this course, and it will be to your benefit to attend class. Group work on tutorial problems is an integral part of your learning experience, and you need to be present to benefit. Exams will be based on material presented in class, homework problems and reading assignments. I expect students to read the assigned material in advance of the class on a topic, and to be prepared to discuss the material in class.

This course is a collaborative effort – please ask questions, offer your ideas and be prepared to participate in the discussion. Written work submitted in this course must be expressed in your own words. I specifically encourage students in this course to work together, but each student must write up her or his own response to homework problems. This step is essential to your learning – writing up the answer to a question requires you to understand the conclusion of your group, whereas transcription of the work of another does not. When in doubt, please ask me what is acceptable.

And of course, while in class, please turn off your phones and other electronic gadgets. (Laptops may be used for note taking if you so desire, but please stay home if you need to surf the web.)

Grading Policy

This course will be graded on the University's traditional letter grade system. Your grade will be based on three midterm exams (10% each), a cumulative final exam (20%), daily homework problems (40% total) and in class iClicker responses (10%). I have not determined in advance how many As, Bs, etc will be assigned – I'm happy to give every student an A if they demonstrate mastery of the material. You are most definitely **NOT** competing with each other for grades! Do work together – you will learn a significant amount from your peers. Along the way I will provide regular updates regarding your grade in the course to avoid any surprises.

Each day, I will assign 1-3 homework problems that will be due at the beginning of the next class. Except in the case of *prior* permission from me, late homework will be docked 20% per weekday (including homework turned in after class). Homework must be legible! If your first attempt is messy, use it as a draft to rewrite a final version for submission. If I can't read it easily, you'll get no credit! Homework problems will be graded on a four-point scale as follows:

4: a good effort with correct results *and* reasoning

3: a good effort with minor conceptual or math errors

2: a fair effort with modest conceptual errors *or* a good effort with serious conceptual errors

1: a very poor effort

0: no effort

A *good effort* involves at least *some* English explanation and use of appropriate diagrams along with any calculations. I expect you to recognize an implausible result if you get one.

Midterm exams take place during regular class time on the scheduled days. Exams will be closed book, and students will be allowed use of calculators and an equation card (to be provided by me in class). If you cannot be present on the scheduled date, tell me *before* the exam day and we can discuss arrangements. For *well-documented* compulsory absences, we will arrange a time for you to take the exam *early*.

Course Guidelines and Policies

Student Conduct Code

The Student Conduct Code at the University of Montana embodies and promotes honesty, integrity, accountability, rights, and responsibilities associated with constructive citizenship in our academic community. This Code describes expected standards of behavior for all students, including academic conduct and general conduct, and it outlines students' rights, responsibilities, and the campus processes for adjudicating alleged violations. Full student conduct code: http://www.umt.edu/vpsa/policies/student_conduct.php

Course Withdrawal

Students may use Cyberbear to drop courses through the first 15 instructional days of the semester. Beginning the 16th instructional day of the semester through the 45th instructional day, students use paper forms to drop, add and make changes of section, grading option or credit. PHSX 141 can only be taken as a traditional letter grade course.

Disability Modifications

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or call 406-243.2243. I will work with you and Disability Services to provide an appropriate modification.

Course Schedule & Reading Assignments

Weeks	Dates	Topic	Readings
1	Aug 27 – 31	The Principle of Relativity	R1
2	Sept 5 – 7	Synchronicity	R2
3	Sept 10 – 14	The Nature of Time	R3
4 – 5	Sept 17 – 28	The Metric Equation *Midterm 1: Fri, Sept 28*	R4
6	Oct 1 – 5	Proper Time	R5
7	Oct 8 – 12	Coordinate Transforms	R6
8	Oct 15 – 19	Lorentz Contraction	R7
9	Oct 22 – 26	The Cosmic Speed Limit *Midterm 2: Fri, Oct 26*	R8
10	Oct 29 – Nov2	Four Momentum	R9
11	Nov 5 – 9	Four Momentum Conservation	R10
12 – 13	Nov 12 – 19	Particle Physics	R10.5
14 – 15	Nov 26 – Dec 7	General Relativity *Midterm 3: Wed, Nov 28*	
	Mon, Dec 10	Final Exam, 8:00 – 10:00 am	