PHY-97: "SPECIAL RELATIVITY"

Syllabus Spring 2018

Prof. Ivan Biaggio, LL 407

MEETING TIMES

Tuesday and Thursday in LL 511, 1:10pm-2:00pm

USEFUL MATERIALS

The first of these books is more introductive, with a strong focus on space-time diagrams. The second one is more discursive and, depending on your sense of humor, can be funny. The third one presents the material more or less at the level that we will follow in this course. You don't necessarily need to immediately purchase any of these books, because I'll also provide class notes summarizing the material and then you can in principle use many sources to study the topics. We'll talk more about these and other books and how they can be used in class.

Thomas A. Moore, "Six Ideas That Shaped Physics, unit R (Relativity)", 2nd Edition.

E. F. Taylor and J. A. Wheeler, "Spacetime Physics," 2nd Edition.

Hans Ohanian , "Special Relativity: A Modern Introduction"

TOPICS

This course will be a development of the special theory of relativity that goes beyond just the standard length contraction and time dilation discussion that you may have encountered already. Topics will include transformation of time and space, momentum and energy, systematic use of Lorentz transformation, and how physical quantities need to be modified in order to be Lorentz invariant. We will discuss space-time intervals, proper time, energy, velocity, momentum, four-vectors, acceleration, forces, the relativistic version of "F=ma". We will discuss how four-vectors change under Lorentz transformations and discuss how physical quantities need to be modified in order to be Lorentz invariant. We will also work with the equations that determine, for example, how time and traveled distance behave on a spaceship accelerating at 1g, talk about what determines the mass of a system, and look at the example of the mass of a system of two photons that are not traveling parallel to each other (turns out it is not zero). Along the way, we will touch on some examples of how special relativity shows up in electromagnetism, and how it modifies our view of some electromagnetic quantities.

LEARNING OUTCOMES

Initial Competences required for this course (what you should know already)

Before starting this course, students should be familiar with calculus, Newtonian mechanics and electromagnetism. The course will assume the ability to work with integrals, derivatives, algebraic equations, differential equations, Maxwell's equations, and vectors.

Course contents (what I will teach in this course)

The course will develop special relativity, and discuss its relationship with electromagnetism, as described in the "Topics" section, above.

Competences expected after this course (what you are expected to be able to do when done)

Students will understand how the rate of time-flow and distances change when moving from one inertial frame to the other, how mass and energy can be converted into each other, and how the relativity principle leads to a new mechanics and kinematics of moving bodies. They will be able to correctly resolve and explain some famous apparent "paradoxes" like the "twin paradox", and correctly calculate spatial dimensions and the flow of time when measured in different reference frames.

COURSE GRADING

The final grade of the course will be determined from the total number of "points" collected by the students. These points are obtained in the two four o'clock exams, the final exam, homework, and quizzes:

Homework	150	(accumulated by adding homework points up to a maximum of 150)
Quizzes	75	(obtained from the grades of the best 7 quizzes)
Exams	300	(75 from mid-term 1, 75 from mid-term 2, and 150 from the final exam)
TOTAL	**525**	

Additional extra-credit points that can also contribute to the above total will be given away as "class participation points". The more active you are in class (for example answering and asking questions), the better; The maximum number of extra-credit points collected in this way is 30. Students taking the course for two credits will collect only half the points, but at the end their points will be doubled, so that the above point totals still apply.

HOMEWORK

Regular Homework (HW)

There will be a new homework assignment each week that counts 12 points.

New assignments are distributed on Tuesdays, discussed on Thursdays, and must be handed in the next Tuesday.

The grading of the homework is based on **effort**, not on correctness. This is how it works:

- You hand in an initial solution, that starts with a few full paragraphs of text explaining the physical effects involved and your approach to solving each problem.
- I look at it, and give it back to you, assigning a number of points between 0 (no effort) to 4 (complete attempt at a solution)
- I provide a solution, either in writing or we derive it in class.
- You then use what you have written before, any comments from me, and the solutions I provided to look at your initial solution again. You then hand it in again, with corrections and comments describing why your approach was wrong. You may add some paper with new work when you do this.
- I look at your final solution and again I assign a number of points between 0 (initial solution was incomplete, and there has been no attempt to improve it) and 4 (all errors where caught and fixed, or maybe there were none in the first place).
- Finally, I assign a number of additional of points, between 0 and 4, that depend on the general quality of the work in both iterations.
- This gives a final tally of 12 points for every homework assignment.

Extraordinary Homework (EHW)

"Extraordinary homework assignments" (**EHW**) are additional homework assignments that follow another format. They are distributed irregularly in class, and depending on discussions and what we are doing you have a more flexible amount of time to work on them. By allowing for multiple discussions in class and more development, these extraordinary assignments will provide a different way to learn a topic. The aim is not even necessarily to complete them in full, it is to discuss its contents and then work with the solutions to understand what is going on.

This homework can often be handed in in pieces as the topic is developed. The work will still be graded like the other assignments, and I will give away points on a 4-4-4 basis whenever you provide me with a piece.

QUIZZES

There will be one short quiz more or less every week. Of all the quizzes, only the best 7 will count towards the 75 Quiz points that contribute to the final grade. There won't be any make-up quizzes.

EXAMS

Exams are closed book, but a summary sheet with the most important facts and expressions will be provided, and you can add some small notes for yourself on it. You don't need to memorize any formula.

Mid-Term Hour Tests

There will be two hour tests that will take place around the usual mid-term period. The grade of the hour tests will contribute to the final grade only if it *improves* on the grade of the final exam. No make-up tests will be given.

Final Exam

There will be one comprehensive final exam.

Exam Grade

Grades of all tests and exams will be merged into one total *exam grade*, which will contribute to the final grade as described by the grade distribution given earlier. This exam grade is either the final exam grade or the result of the weighted average between the mid-term grades m_1 and m_2 and the final grade f, with the final carrying twice the weight of a hour test. As an example, the final grade will be calculated via

$$(m_1 + m_2 + 2f)/4$$

if the result is larger than the final grade f. But if one of the mid-terms was so bad that it would work against you, then the total exam grade will be calculated via $(m_i + 2f)/3$, where m_i is the grade of the other midterm. Or if the grade in the final exam is better than both mid-term exams, then your final exam grade will be just the grade of the final exam. This means that you can do badly in the hour tests and not suffer any consequences if you do well in the final exam.

Beware that this rule should not mean that you don't prepare for the mid-terms. Doing well on the mid-term will alleviate a lot of anxiety because the grade you get helps with the final grade. Also, what you study for the mid-terms is something you won't need to work with as much for the final!

READING ASSIGNMENTS AND HOW TO USE THEM

I will provide written weekly summaries of what I do in class, and suggest some additional reading. Scrupulously follow the reading assignments, and don't be a minimalist. You will do best if you read ***more*** than just what I suggest.

A NOTE ON ACADEMIC INTEGRITY, ETC.

Academic integrity applies to all we do. Teamwork on tests is cheating. Doing homework as a team and especially copying the solutions of homework assignments are also against academic integrity: please see the links in the top-left corner when you enter coursesite. In any case, some nice discussions among friends are always a good way to learn and exercise the material, but do try to work on the assignments alone. Always relying on help from others will work against you because it will not allow you to identify the areas where you have more difficulties.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, Williams Hall, Suite 301 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

THE PRINCIPLES OF OUR EQUITABLE COMMUNITY

Lehigh University endorses The Principles of Our Equitable Community. We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

[http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf]

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