PHYS 428/628: Relativity

Classes

Place: PLANET 220
Time: MW 10:30–11:45
Web site: www.physics.gmu.edu/∼joe/PHYS428.html

Instructor

Joe Weingartner (call me Joe)
Planetary Hall, room 231
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Office hours: T 2:00–3:00, W 12:30–2:00, or by appointment

Optional Textbooks

Relativity: *Special, General, and Cosmological*, 2nd ed, W. Rindler (Oxford University Press)

Introduction to Electrodynamics, 3rd ed, D. J. Griffiths (Prentice Hall)

Evaluation

Homework (60%)
1. You are encouraged to discuss the problems with one another, but the detailed solutions that you submit must be your own, independent work.
2. Do not hesitate to seek help from me, in person, over the phone, or by email.
3. The point value of each problem is indicated in brackets. The total number of points for the semester will be 690 for PHYS 428 and 840 for PHYS 628.
4. Homework will be due at the start of class on the announced dates. Late homework will only be accepted in extenuating circumstances.
5. The clarity of your solutions will factor significantly into your grade. It is not sufficient to write a few equations. You must define your variables, draw well labeled figures where appropriate, and explain what you're doing. Use the distributed solutions to sample problems and homework problems as a guide for the level of detail required. Also, you must write legibly. I will not struggle to decipher handwriting; instead, I will simply assign zero points.
6. Each week, I will choose a fraction (possibly 100%) of the submitted problems to grade. Of course, I will not reveal in advance which problems will be graded. Your total earned points for each submission will be AB/C, where C is the total number of points in the graded problems, A is the number of points you earned on those problems, and B is the total number of points in the problems on which you made a serious effort.
7. Unless explicitly stated, you may not use computer programs like Mathematica.
8. When a problem asks you to "show" something, this should be interpreted as "derive" rather than "verify".
9. Problem sets for PHYS 628 are longer than those for PHYS 428. The additional problems are more mathematically challenging and probe the physics to greater depth.

2 in-class exams (10% each)
Exam 1 will cover Topics 1–4 and is tentatively scheduled for March 1.
Exam 2 will cover Topics 5–8 and is tentatively scheduled for April 17.

Final exam (20%)
This will be held on May 10, 10:30–1:15, in the same room as class. It will cover all the course material, but Topics 9–11 will be more heavily represented than the earlier material.

Letter grades for the course will be determined from total numerical grades as follows:
A range: 87-100%
B range: 74-87%
C range: 64-74%
D: 55-64%
F: $< 55\%$

Course Outline

1. Motivation for Special Relativity
2. The Foundations of Special Relativity
3. Spacetime and 4-vectors
4. Relativistic Mechanics
5. Introduction to Tensors
6. Electrodynamics
7. Introduction to General Relativity
8. Geodesics in Curved Spacetime
9. Curvature and Einstein's Field Equations
10. The Schwarzschild Metric and Applications
11. Introduction to Cosmology

Recommended Reading (by topic)

1. Rindler 1.1 through 1.10; Griffiths 1.2, 7, 12.1.1, Appendix C
2. Rindler 2.1 through 2.8, 3.1 through 3.6, 4.3; Griffiths 12.1.2 and 12.1.3
3. Rindler 5.1, 5.4 through 5.6; Griffiths 12.1.4, 12.2.1
4. Rindler Ch 6 (omit 6.5 and 6.8); Griffiths 12.2.2 through 12.2.4
5. Rindler 7.1, 7.2
6. Rindler 7.3 through 7.7; Griffiths 12.3
7. Rindler 1.11 through 1.16
8. Rindler 8.3, 8.4, 10.1 through 10.4
9. Rindler 10.5, 10.6, 14.1, 14.2
10. Rindler 11.1, 11.2, 11.5 through 11.12
11. Rindler 16.1 through 16.5 (except 16.3), 17.2, 18.1 through 18.4

Recommended Study Strategy

For each topic, lecture notes will be available on the course web site in pdf format. During the lectures, structure your own note taking around the printed course notes. The pace will be too quick for you to write down everything on your own. Focus on writing down clarifications and extra detail not contained in the printed notes.

Only part of the class time will be devoted to lectures. We will also spend a lot of time working sample problems. I'll distribute these problems, as well as detailed solutions, before class. Please print these and bring them to class. You may want to jot additional notes on them.

After class, carefully review your lecture notes and the worked problems. Read or reread the relevant sections of the optional textbooks, if you find these helpful. Make note of anything you don't understand and ask me about it at my office or at the next class.

The homework assignments will be challenging. For many problems, you will probably need to make multiple attempts in order to achieve the full solution. For this reason, it is critical that you start working on the problem set shortly after it is assigned. Allow yourself plenty of time to seek help, both from me and from your classmates. I suggest that you form study groups and meet regularly to discuss the problems. But make sure that you've put in serious effort before meeting with your classmates!

After class, I will distribute solutions to the homework. Carefully study the solutions, regardless of how well you did on the problems. You may find that my solution differs from yours, and it can be very valuable to have the additional perspective. Redo the homework problems (and sample problems) until you can easily solve them without the use of aids (except for the formulas sheet).