Physics 155: General Relativity (Spring 2013)

Lectures: TR 9-10:20am in room 185

Instructor: Prof. David Wittman, Physics 529, 530-554-2354, dmwittman@ucdavis.edu. Office hours MW 2:30-3:30.

Prerequisites: Physics 104A, 105AB, and 110A. If you don't have all the prereqs, you **must** contact me to discuss your situation.

Textbook: *A General Relativity Workbook* by Thomas Moore.

Course structure and expectations: The idea behind the "workbook" is that you have to fill in some of the steps of the important derivations, thus giving you a feeling that you own the math rather than "here is a result, your eyes probably glazed over the steps of the derivation so now it's a bit of a mystery to you." We will do roughly one chapter per 80-minute class meeting; the short chapter length is intended for 50-minute class meetings but this will help us make sure that we really understand things before moving on. (Some weeks, we may do 3 chapters per 2 meetings.) In class, students will present their work filling in the missing steps in the derivations in the workbook, writing them on the whiteboard and discussing them. We will also have time to discuss what the results really *mean*, including practice applying the results in new contexts. Finally, there will be a few homework problems for you to do by the following class, to give you practice doing those applications on your own.

This is a 4-unit course, so you are expected to spend 12 hours per week on this course; in other words, **9 hours per week outside of lecture.** We will try to set up an optional (but strongly recommended) weekly problem-solving section with the TA. For almost every class meeting, you will be expected to read the relevant chapter and fill in the chapter-end "boxes" **before** class, present your work on the chapter-end "boxes" in class, **and** hand in homework problems building on the material we discussed at the previous class meeting. Each class, I will randomly select a few students to hand in their "box" work for me to check.

Grading: I intend to grade using the weights below. However, because this is a new course format, I reserve the right to adjust these weights as we learn how to make this format work best.

- In-class participation: 20%. You must be ready for participation by reading and doing the "boxes" before class, so random "box" checks are part of this grade. Everyone gets one (but only one) chance to be unprepared or absent when called on. Beyond that, you will need a doctor's note.
- Homework: 60%. Teamwork is encouraged on the homework, within reasonable limits. You will learn more by tackling problems together and/or comparing results, but you must always submit your own work based on your own unique understanding.
- Midterm exam: 8%. This will be take-home. The difference between a homework and a take-home exam is that you are not allowed to collaborate on a take-home exam.
- Final exam: 12%.

Schedule: The following schedule is tentative. Please refer to page xvii of the book to see the logical dependence of the chapters nicely laid out. "Boxes" refer to the end-of-chapter boxes; "present" means you write your solution on the whiteboard and discuss it; and homeworks are numbered according to the chapter they address rather than consecutively.

Date	Before class	In class	Turn in
Tue Apr 2 (Week 1)	Read Ch 1 (Intro/GR in a Nutshell) and do HW 1 (P1.3-1.5)	Course overview. Present HW 1. Discuss meaning of Ch 1.	HW1
Th Apr 4	Read Ch 2 (Review of SR) and do boxes.	Present Ch 2 boxes. Review SR.	
T Apr 9 (Week 2)	Read Ch 3 (Four-vectors) and do boxes.	Present Ch 3 boxes.	HW2
Th Apr 11	Read Ch 4 (Index Notation) and do boxes.	Present Ch 4 boxes.	HW3
T Apr 16 (Week 3)	Read Ch 5 (Arbitrary Coordinates) and do boxes.	Present Ch 5 boxes.	HW4
Th Apr 18	Read Ch 6 (Tensor Equations) and do boxes.	Present Ch 6 boxes.	HW5
T Apr 23 (Week 4)	Read Ch 7 (Maxwell's Equations) and do boxes.	Present Ch 7 boxes. Interpret manifestly relativistic form of Maxwell's Equations.	HW6
Th Apr 25	Read Ch 8 (Geodesics) and do boxes through 8.5.	Present boxes through 8.5. **Hand out take-home exam.**	HW7
Take-home exam is due Monday. There is no HW due Tuesday (but boxes are still due Tuesday).			
T Apr 30	Finish Ch. 8 boxes, read Ch 9 (Schwarzschild metric) and do	Present Boxes 8.6-8.7 and Ch 9 boxes.	

(Week 5)	boxes.		
Th May 2	Read Ch 10 (Particle Orbits) and do boxes.	Present Ch 10 boxes.	HW8 (questions from Ch 8-9)
T May 7 (Week 6)	Read Ch 11 (Perihelion Precession) and do boxes.	Present Ch 11 boxes.	HW9
Th May 9	Read Ch 12-14 and do Ch 14 (Event Horizon) boxes.	Present Ch 14 boxes.	HW10
T May 14 (Week 7)	Read Ch 17 (Absolute Gradient) and do boxes.	Present Ch 17 boxes.	HW11
Th May 16	Read Ch 18 (Geodesic Deviation) and do boxes.	Present Ch 18 boxes.	HW12
T May 21 (Week 8)	Read Ch 19 (Riemann Tensor) and do boxes.	Present Ch 19 boxes.	HW13
Th May 23	Read Ch 20 (Stress-Energy) and do boxes.	Present Ch 20 boxes.	No HW due today!
T May 28 (Week 9)	Read Ch 21 (Einstein Equation) and do boxes.	Present Ch 21 boxes.	HW14 (problems from Ch 19-20)
Th May 30	Read Ch 22 (Interpreting the Equation) and do boxes.	Present Ch 22 boxes.	No HW due today!
T June 4 (Week 10)	Read Ch 23 (Schwarzschild solution) and do boxes 23.1-23.2.	Catch up to Box 23.2	HW15
Th June	Read Ch 35	Present boxes 23.3-23.5.	No HW due

6	(Gravitomagnetism) and finish Ch 23 boxes.	Course evaluations.	today!

Final exam will be take-home, to be handed out at the last class and due Wednesday June 12 at 5pm.