Class Meeting: **M**, **W** & **F** 1:30-2:30pm and TBD
Class Location: Heg 201
Office Hours: **TBD**

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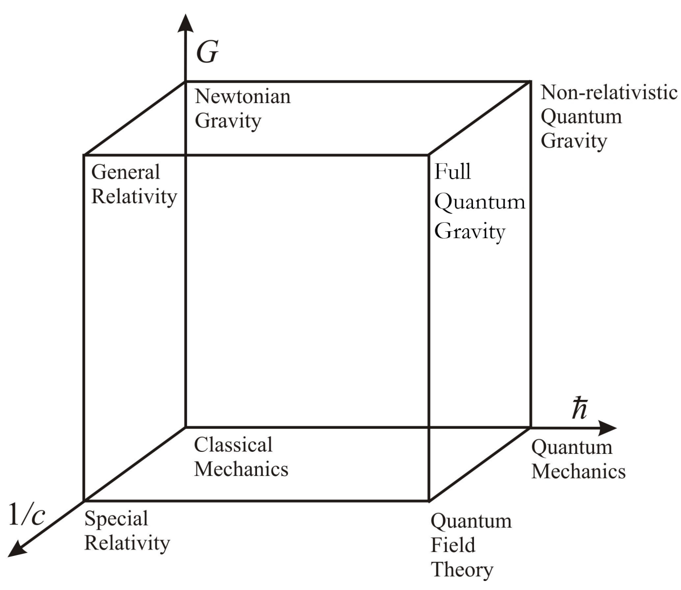
Course Description — Isaac Newton had this to say about his theory of gravity, which dominated the description of gravitationally interacting bodies for more than 200 years,

> That one body may act upon another at a distance through a vacuum without the mediation of anything else, by and through which their action and force may be conveyed from one another, is to me so great an absurdity that, I believe, no man who has in philosophic matters a competent faculty of thinking could ever fall into it.

Through asking a wonderful set of questions, such as, "What would it be like to ride a beam of light? If a man falls freely, would he not feel his weight? If we knew what it was we were doing, it would not be called research, would it?", Einstein began to address Newton's conundrum. The result was one of the most stunning achievements of modern physics—a geometric, field theory of gravity. This theory is a beautiful and intricate synthesis of mathematics and physics.

The general theory of relativity allows us to describe the formation of black holes, the evolution of the entire universe, and the undulations of spacetime in gravitational waves, which are likely to be measured directly for the first time in the next three years. Without its predictive capabilities the Global Positioning System (GPS) would be useless within half an hour. And despite these spectacular successes, we still have not learned the right question to ask to open a royal road to quantum gravity. In Einstein's words:

> If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask for once I know the proper question, I could solve the problem in less than five minutes.



Text: *Gravity: An Introduction to Einstein's General Relativity*, by J. B. Hartle (Addison-Wesley, 2003)

Take home — This will be an unlimited time, open-book exam. You can study as much as you like using any resource up to opening the exam. However, once you have opened the exam I ask that you only refer to your class notes and our primary text. I ask that you honor your peers and the effort that we all put into the class by not referencing any outside materials.

Grading Structure

Attendance	5%
Weekly Homework (due on Fridays)	35%
Quizzes	5%
In-class exam	25%
Take home	30%

Homework — There will be homework due every Friday at 5pm. Complete solutions will be posted. I will grade a portion of the problems on a 0-5 scale. These scores mean roughly the following: 5=clear and complete solution, 4=good solution missing one conceptual point or calculation, 3=clear attempt but with substantive flaw, 2=effort made but incomplete plan, 1=little effort, 0=nothing appearing. I care most about the effort you invest and you can receive credit on this basis. The goal of the homework is for us to engage each other in a discussion of physics regularly, please come and visit as often as you like to discuss. Along these lines, I recommend that you work together; this is invaluable in learning physics. Please write things up yourself to show me and you that you understand it (this helps battle the illusion of explanatory depth, which is worth looking up). Please do not use the internet as a resource for anything but physics books.

Course website: `http://bohr.physics.berkeley.edu/hal/teaching/phys327Sp16/`

Week	Topics	Chap.
2/1	What is GR? What is geometry? Lagrangian Mechanics	1-3
2/8	Geometry of SR, SR effects, kinematics	4
2/15	SR dynamics, 4-vectors (**2/17 Drop/Add**)	5
2/22	Equivalence principle, Time dilation, Particle motion	6
2/29	Weak fields & Newton, Coordinates, Vectors in curved geometry	7
3/7	Curved spacetime, Geodesics	8
3/14	Geometry outside a spherical star (in-class midterm)	9
3/21	**Spring Break**	
3/28	Gravitational collapse and black holes	12
4/4	Vectors, dual vectors & tensors	20
4/11	Covariant derivatives & curvature	20-21
4/18	Einstein's equations	Hal's notes
4/25	Deriving black holes & Black holes in the sky	Hal's notes, 13
5/2	(**MT 5/2-3 Adv. day**) Gravitational waves	16
5/9	Generating Gravitational waves	23
5/16	*Completion days begin W 5/18* (**Take home due 5/20, 5pm**)	
	Quantum gravity	Hal's notes

Note: I reserve the right to adjust this syllabus during the semester

Quizzes — Sporadic brief (10-15min) quizzes will help you keep track of what you should know and the few equations you should memorize.

Lateness and Other Anomalies — I will usually grade your homework over the weekend and return it to you in class on Monday. Late work will be accepted before I have graded that week's assignment with a 20% deduction on the graded score. After a set has been graded I will no longer accept late work. If you tell me about something ahead of time, almost any situation can be accommodated.

Further recommended books: Even more so than in other courses, it is essential that you build your only mental models for understanding general relativity. If our course text is not speaking to you, try some of these books to get other perspectives.

Spacetime and Geometry: An Introduction to General Relativity, by S. Carroll
A wonderful book, which is at a slightly more advanced level than our text.

Spacetime Physics, by E. F. Taylor and J. A. Wheeler
Wheeler and Taylor are creative and deeply care about teaching. This book is slightly easier than our course text.

An Introduction to Tensors and Group Theory for Physicists, by N. Jeevanjee
An outstanding book, written by a friend, that explains with care the mathematics of tensors. The half of the book on tensors is only about 90 pp and well worth your time.

A First Course in General Relativity, by B. Schutz
Schutz is an excellent writer and this book should appeal to those of you with a more mathematical bent.

A Short Course in General Relativity, by J. Foster & J. D. Nightengale
Another popular book, but one that I have not spent any time with.

Gravitation, by C. W. Misner, K. S. Thorne, and J. A. Wheerler
Not for the faint of heart, but full of wonderful insights. A standard graduate text from the '70s.

I have read over this syllabus. I agree not to look at solutions manuals or use the internet for anything other than looking up reference information. Finally, I commit to stick to the parameters of the take home exams.

Signed: Date: