

# PHYSICS 3A03 — INTRODUCTION TO GENERAL RELATIVITY

GENERAL INFORMATION, Winter Term 2013

Einstein's General Theory of Relativity — General Relativity, or GR, for short — postulates that the geometry of spacetime is a dynamical physical quantity that evolves according to equations of motion as do other physical fields, and that the physical manifestations of spacetime curvature are what we interpret as gravity. General Relativity, together with Maxwell's electromagnetism, provides our current best picture of the two fundamental forces that are known to act over macroscopic distances, underlie the vast majority of the phenomena studied in Physics and Astronomy.

This course is intended to give a first introduction to General Relativity, aimed at upper-year physics undergraduates. It is meant to be self-contained, and so contains a rudimentary introduction to the required mathematics that is not already part of the normal physics curriculum (like calculus, linear algebra and differential equations). The course is neither a survey course for nonspecialists, nor a substitute for a course on differential geometry. What follows is a list of the course's procedural information.

- **Instructor:** Cliff Burgess

Office      ABB 324  
Phone:     x23175  
email:      cburgess@physics.mcmaster.ca

- **Lectures:** Lectures meet Mondays from 14:30 to 16:20 and on Thursdays from 15:30 to 16:20 in HH 305. Attendance to the lectures is not compulsory, but if you come I ask you to pay attention and not disrupt the class with personal conversation. I will do what I can to ensure that you do not have to gnaw your own arm off to stay awake.
- **Course Outline:** There are five main topics which I intend to cover:

**Topic**    *Elements of Geometry*  
              *Special Relativity as Flat Spacetime*  
              *Einstein's Equations*  
              *Weak Gravity and the Solar System*  
              *Strong Gravity and Black Holes*  
              *Cosmology and the Universe as a Whole*

- **Textbook:** The course text is *Gravity, An Introduction to Einstein's General Relativity*, by Jim Hartle, and has been ordered at the bookstore. Other texts which you may find useful as supplements are Sean Carroll's *Spacetime and Geometry*; Steven Weinberg's *Gravitation and Cosmology; A First Course in General Relativity* by Bernard Shutz; and Paul Dirac's *General Theory of Relativity*. Hartle and Shutz's books are aimed at undergraduate audiences, Weinberg's and Dirac's are timeless classics, and Carroll's is a good modern introductory graduate text. While some of these will be aimed at a slightly higher level than the course, they will reward a bit of elbow grease with many insights.

- **Office Hours:** Because I spend half my time at Perimeter Institute I may be hard to find in my office, so it is worth setting up any appointments in advance. I will reserve the time immediately after the class (starting at 16:30) if you would like to see me about anything, so either catch me in class or tell me there that you intend to meet me in my office. (I will not just hang about the office during that time unless I know students are coming by, so it is important to let me know in advance if you intend to stop in.) Otherwise, feel free to arrange another time with me on an individual basis. (I will make a point of being in my office for scheduled appointments, so if you *do* set up an appointment, please show up!)
- **Marking Scheme:** The course marks are completely based on weekly assignments, a midterm test, and the final exam. The term mark will be computed from these according to whichever of the following formulae maximizes your final mark:

Item	Option A	Option B	Option C
Assignments	20%	20%	20%
Midterm Test	30%	15%	0%
Final Exam	50%	65%	80%

- **Midterm Test:** A 90-minute midterm test will be held on Monday, March 4th 2013. The midterm provides the best possible practice for the final exam, so it would be silly not to write it. Those who do not write the midterm for whatever reason can avail themselves of Option C above. Be there or be square.
- **Final Exam:** The Final Exam will be held during the April examination session.
- **Additional Work and Supplemental Exam:** Additional work will NOT be available for students who might wish to improve their marks. The standard McMaster rules apply regarding the availability of supplemental exams.
- **Reading you your rights:** The Centre for Student Development offers free academic skill support (see <http://csd.mcmaster.ca> for details). Although hopefully it does not need saying, be warned that the University does not tolerate cheating, plagiarism and the like. THE UNIVERSITY VALUES ACADEMIC INTEGRITY. THEREFORE ALL STUDENTS MUST UNDERSTAND THE MEANING AND CONSEQUENCES OF CHEATING, PLAGIARISM AND OTHER ACADEMIC OFFENCES UNDER THE CODE OF STUDENT CONDUCT AND DISCIPLINARY PROCEDURES (see <http://www.mcmaster.ca/academicintegrity> for more information).