# PHY 490 - Introduction to General Relativity

**Syllabus** **Dr. R.L. Herman** **Spring 2008**


**Instructor:** Dr. R. Herman
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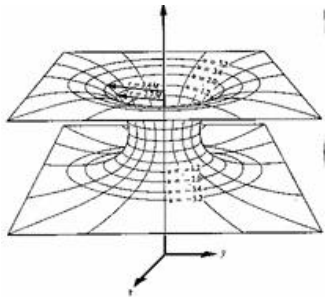
## Course Content:

**Required Text:** *Gravity: An Introduction to Einstein's General Relativity,* James B. Hartle, Addison-Wesley, 2003.

## Course Philosophy:

One of the greatest achievements in theoretical physics, only later to lead to exciting frontiers in experimental and computational physics, was Einstein's development of the General Theory of Relativity from 1907 to 1915. General Relativity is a theory of gravity and is necessary to understand recent advances at the forefront physics research, including black hole physics, the early universe, string theory, high energy physics and astrophysics.
In this course students will be carried from Newtonian dynamics and special relativity into the physics of curved space times. We will be lead into the space-time of spherical stars to rotating black holes. Along the way we will explore a variety of applications in cosmology from the big bang to gravitational waves and cosmological models of the universe.
General Relativity is a theory of gravitation. There are many texts on the subject, most aimed at beginning graduate students and beyond. There are a variety of approaches depending upon the balance between physics and mathematics and the geometrical approach taken. In this course we will set out to provide the physical foundations and develop the geometric background needed to understand some of the consequences of general relativity and to prepare students for reading graduate level texts.

We will begin with an overview of special relativity and an introduction to four vectors and the geometry of flat spacetime. Having examined inertial systems, we then move on to acceleration and gravity. This will lead to the introduction of curved spacetime and the study of the motion of test particles and light waves. Classic tests of general relativity can then be discussed as well as an assorted list of applications to cosmology, including black holes, gravitational waves and the big bang. If there is time, we will provide an overview of the Einstein equations.



**Prerequisites:** Junior/Senior Standing. Preferably, students should have had a course in classical dynamics and should have completed Calculus III. Additional mathematics and physics is a plus. Interested students should contact Dr. Herman for additional information.

## Course Requirements:

**Homework:** Homework assignments will be collected on a regular basis and you will be told when the work is due. As doing homework is very important for learning the material in this course, it will count as 30% of your grade.

**Papers/Projects:** There are many interesting areas that might best be explored by individuals, or groups, outside the classroom. Such topics may arise in the course of the semester. You will be required to do at least two in-depth papers in this class. This will count 10% of your grade.

**Exams and Grades**: There will be a two 50 minute exams and a final exam. The exams will cover the basic material up to the date of the exam. The tentative dates for the exams are below.

| Exams | Date |
|---|---|
| Exam I | Feb 11 |
| Exam II | Apr 2 |
| Final | May 5, 8:00 AM |

Your final grade will be based on the following:

| | |
|---|---|
| Homework | 30% |
| Papers/Projects | 10% |
| Exams | 45% |
| Final | 15% |

| | |
|---|---|
| 90-100 | A |
| 80-89.5 | B |
| 70-79.5 | C |
| 60-69.5 | D |

**Plus-minus grading may be used in special cases.**

**This syllabus is subject to change!**

# Homework Assignments

You should do as many problems as you can to become proficient in this class. However, you are required to turn in all of the assigned problems for grading on the due date. All work is expected to be neat, in order and with all work provided. The homework assignments are listed at the course website. [See below.]

# Materials on the Web

More information will be posted on the web related to the topics we are studying. Links can be found with summaries to the material, study suggestions, homework assignments, etc. These will be accessible through the instructor's homepage at **people.uncw.edu/hermanr/gr**

# Group Work:

In this course you will occasionally work with other students to complete a task. For many of you group work will be a new experience. In order to make this experience both productive and enjoyable, we offer the following suggestions:

- Start the project as soon as it is assigned. Do not put it off until the last minute. Some of the assignments will take time and working in a group may require more time due to scheduling difficulties.
- Read over the entire assignment, carefully before discussing or completing any part of it.
- Initially, you may have no idea as to how to get started. Don't panic! Discuss the lab with the group and generate some ideas.
- Group work is not always as straightforward as standard homework assignments. You may need to make some assumptions and later justify these assumptions, indicating how they affect your results.
- The final report should be thoughtful, well-written and neatly organized. It should summarize your approach to the problem, present your results and conclusions, and be furnished with full explanations.
- If you have investigated the project as far as possible and still have questions, or there is a need for clarification of some point, then discuss them with your instructor before writing the report.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**Academic Honor Code:** "The University of North Carolina at Wilmington is committed to the proposition that the pursuit of truth requires the presence of honesty among all involved. It is therefore the institution's stated policy that no form of dishonesty among its faculty or students will be tolerated. Although all members of the university community are encouraged to report occurrences of dishonesty, each individual is principally responsible for his or her own honesty." Student Handbook. *(This includes plagiarism, bribery and cheating.)*

**Student Disabilities:** UNCW Disability Services supplies information about disability law, documentation procedures and accommodations that can be found at www.uncw.edu/stuaff/disability/ .
To obtain accommodations the student should first contact Disability Services and present their documentation to the coordinator for review and verification. (If you feel that you should qualify for disability testing or accommodations during this course, contact the Office if Disability Services in Westside Hall or call ext. 3746.)