

## Course Syllabus

# PHYS 5210: Introduction to Gravitation

## Lecture

TH 2:00-3:20 PM, PHYS 205

## Course Description

An introduction to Einstein's theory of gravity appropriate for undergraduates. Topics covered will include a brief discussion of special relativity, manifolds and elements of differential geometry, curvature, gravitation and Einstein's Equation, the Schwarzschild solution and black holes, and gravitational radiation. There will be a computational aspect to the course. This course is appropriate for advanced undergraduate students in physics, astronomy, or mathematics.

Prerequisites: PHYS 3730, and PHYS 4410 or PHYS 5010.

## Instructor

Douglas Bergman

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Office hours: W 2-3

## Textbook

[A First Course in General Relativity \(2nd Edition\)](#), Schutz, Cambridge University Press, 2009. ISBN: 978-0-521-88705-2.

## Homework

There will be roughly one homework per week (assigned Thursday, due in class the following Thursday). One problem, chosen at random, from the assigned homework will be graded for credit. The graded homework will be returned on Thursdays. Students are expected to attempt problems on their own. Discussions with other students are permitted, but students should turn in their own work. The first homework will be due on August 30.

## Exams

There will one midterm exam, **2018/10/23**, to be administered during the regular class time and in the class room. There will be a two-hour final examination on **2018/12/10** from 1:00 – 3:00 PM in the class room.

## Project

There will be a group project due by the end of the last class, **2018/12/06**.

## ADA Statement

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations.

## Rights & Responsibilities

All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, and I will do so, beginning with verbal warnings and progressing to dismissal from and class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.

## Weekly Schedule

**Week 1 (8/21-23): Special Relativity**

**Week 2 (8/28-30): Vector Analysis in SR**

**Week 3 (9/4-6): Tensor Analysis in SR**

**Week 4 (9/11-13): Tensor Analysis in SR**

**Week 5 (9/18-20): Perfect Fluids in SR**

**Week 6 (9/25-27): Coordinate Systems**

**Week 7 (10/2-4): Curved Manifolds**

**Week 8 (10/16-18): Curved Manifolds; Review**

**Week 9 (10/23-25): Midterm; Physics in Curved Spacetime**

**Week 10 (10/30-11/1): Einstein's Equations**

**Week 11 (11/6-8): Weak Gravitational Fields; Gravitational Radiation**

**Week 12 (11/13-15): Gravitational Radiation**

**Week 13 (11/20): Spherical Solutions for Stars**

**Week 14 (11/27-29): Stars, Black Holes**

**Week 15 (12/4-6): Black Holes, Cosmology**

## Course Summary:

Date	Details	
Tue Aug 21, 2018	 <b>Schutz 1.1-1.6</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011761">https://utah.instructure.com/courses/501430/assignments/5011761</a> )	due by 2pm
Thu Aug 23, 2018	 <b>Schutz 1.7-1.13</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011874">https://utah.instructure.com/courses/501430/assignments/5011874</a> )	due by 2pm
Tue Aug 28, 2018	 <b>Schutz 2.1-2.4</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011877">https://utah.instructure.com/courses/501430/assignments/5011877</a> )	due by 2pm
Thu Aug 30, 2018	 <b>Homework 1</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251616">https://utah.instructure.com/courses/501430/assignments/5251616</a> )	due by 2pm
	 <b>Schutz 2.5-2.8</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011878">https://utah.instructure.com/courses/501430/assignments/5011878</a> )	due by 2pm
Tue Sep 4, 2018	 <b>Schutz 3.1-3.3</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011879">https://utah.instructure.com/courses/501430/assignments/5011879</a> )	due by 2pm

### Homework 2

Thu Sep 6, 2018	 ( <a href="https://utah.instructure.com/courses/501430/assignments/5251617">https://utah.instructure.com/courses/501430/assignments/5251617</a> )	due by 2pm
	 <b>Schutz 3.3</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5539408">https://utah.instructure.com/courses/501430/assignments/5539408</a> )	due by 2:00pm
Tue Sep 11, 2018	 <b>Schutz 3.3-3.6</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011880">https://utah.instructure.com/courses/501430/assignments/5011880</a> )	due by 2:00pm
Thu Sep 13, 2018	 <b>Homework 3</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251618">https://utah.instructure.com/courses/501430/assignments/5251618</a> )	due by 2pm
	 <b>Schutz 3.6-3.10, 4.1-4.2</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011881">https://utah.instructure.com/courses/501430/assignments/5011881</a> )	due by 2:00pm
Tue Sep 18, 2018	 <b>Schutz 4.3-4.5</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011882">https://utah.instructure.com/courses/501430/assignments/5011882</a> )	due by 2:00pm
Thu Sep 20, 2018	 <b>Homework 4</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251619">https://utah.instructure.com/courses/501430/assignments/5251619</a> )	due by 2pm
	 <b>Schutz 4.6-4.8</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5539364">https://utah.instructure.com/courses/501430/assignments/5539364</a> )	due by 2:00pm
Tue Sep 25, 2018	 <b>Schutz 5.1-5.3</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011884">https://utah.instructure.com/courses/501430/assignments/5011884</a> )	due by 2:00pm
Thu Sep 27, 2018	 <b>Schutz 5.4-5.6</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011954">https://utah.instructure.com/courses/501430/assignments/5011954</a> )	due by 2:00pm
Fri Sep 28, 2018	 <b>Homework 5</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251621">https://utah.instructure.com/courses/501430/assignments/5251621</a> )	due by 2:00pm
Tue Oct 2, 2018	 <b>Schutz 6.1-6.2</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011998">https://utah.instructure.com/courses/501430/assignments/5011998</a> )	due by 2pm
Thu Oct 4, 2018	 <b>Schutz 6.3-6.4</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011999">https://utah.instructure.com/courses/501430/assignments/5011999</a> )	due by 2pm
	 <b>Homework 6</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251623">https://utah.instructure.com/courses/501430/assignments/5251623</a> )	due by 2:00pm
Thu Oct 18, 2018	 <b>Homework 7</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251624">https://utah.instructure.com/courses/501430/assignments/5251624</a> )	due by 2:00pm

Tue Oct 23, 2018	 <b>Midterm</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5011948">https://utah.instructure.com/courses/501430/assignments/5011948</a> )	due by 3:20pm
Tue Oct 30, 2018	 <b>Schutz 6.5-6.7</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012002">https://utah.instructure.com/courses/501430/assignments/5012002</a> )	due by 2:00pm
Thu Nov 1, 2018	 <b>Homework 8</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251625">https://utah.instructure.com/courses/501430/assignments/5251625</a> )	due by 2pm
	 <b>Schutz 7.1-7.3</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012003">https://utah.instructure.com/courses/501430/assignments/5012003</a> )	due by 2:00pm
Tue Nov 6, 2018	 <b>Schutz 7.4</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012005">https://utah.instructure.com/courses/501430/assignments/5012005</a> )	due by 2:00pm
	 <b>Schutz 8.1-8.2</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012007">https://utah.instructure.com/courses/501430/assignments/5012007</a> )	due by 2:00pm
Thu Nov 8, 2018	 <b>Homework 9</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251626">https://utah.instructure.com/courses/501430/assignments/5251626</a> )	due by 2:00pm
	 <b>Schutz 8.3-8.4</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012011">https://utah.instructure.com/courses/501430/assignments/5012011</a> )	due by 2:00pm
Tue Nov 13, 2018	 <b>Schutz 9.1</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012012">https://utah.instructure.com/courses/501430/assignments/5012012</a> )	due by 2:00pm
Thu Nov 15, 2018	 <b>Homework 10</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251627">https://utah.instructure.com/courses/501430/assignments/5251627</a> )	due by 2:00pm
	 <b>Schutz 9.2</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012013">https://utah.instructure.com/courses/501430/assignments/5012013</a> )	due by 2:00pm
Tue Nov 20, 2018	 <b>Schutz 9.3-9.5</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012014">https://utah.instructure.com/courses/501430/assignments/5012014</a> )	due by 2:00pm
Tue Nov 27, 2018	 <b>Schutz 10.1-10.4</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012015">https://utah.instructure.com/courses/501430/assignments/5012015</a> )	due by 2:00pm
Thu Nov 29, 2018	 <b>Homework 11</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5251628">https://utah.instructure.com/courses/501430/assignments/5251628</a> )	due by 2:00pm
	 <b>Schutz 10.5-10.7</b> ( <a href="https://utah.instructure.com/courses/501430/assignments/5012016">https://utah.instructure.com/courses/501430/assignments/5012016</a> )	due by 2:00pm

Tue Dec 4, 2018

**Schutz 11.1-11.2**<https://utah.instructure.com/courses/501430/assignments/5012017>

due by 2:00pm

**Homework 12**<https://utah.instructure.com/courses/501430/assignments/5547950>

due by 2:00pm

**Project**<https://utah.instructure.com/courses/501430/assignments/5540019>

due by 2:00pm

Thu Dec 6, 2018

**Schutz 11.3-11.5**<https://utah.instructure.com/courses/501430/assignments/5012018>

due by 2:00pm

**Schutz 12**<https://utah.instructure.com/courses/501430/assignments/5250880>

due by 2:00pm

Mon Dec 10, 2018

**Final Exam**<https://utah.instructure.com/courses/501430/assignments/5012770>

due by 3pm