

# Physics 581: General Relativity

Spring 2021 (3 credits)

TuTh 10:35-11:50am

Online

Instructor: Dr. Matthew Duez  
Office Location: Webster 947E  
Phone: (509) 335-2396  
Email: [m.duez@wsu.edu](mailto:m.duez@wsu.edu)  
Office hours: Wednesday 2-3pm

## Textbooks

**Required:** *Spacetime and Geometry* by Sean Carroll

## Student Learning Outcomes

Students will learn

- differential geometry applied to Riemannian manifolds: tensors, killing vectors, geodesic congruences, foliations, curvature and geodesic deviation
- black hole spacetimes, through a detailed study of the Schwarzschild and Kerr metrics
- the linearized Einstein equations and gravitational waves
- cosmological models for homogeneous, isotropic universes

## Grade Breakdown

Homeworks:	70%
In-class exercises (participation)	15%
Take-home final exam:	15%

## Homework

There will be roughly one homework assignment per week, usually due on Thursday. Homework will be distributed and submitted on the course blackboard page. Homework submitted after the due date will receive a late penalty of 10% per day (unless the student contacts the instructor about the student's circumstances ahead of time).

## In-class exercises

Class participation will be assessed by participating in group exercises in breakout rooms. These will occur roughly once a week, usually on Tuesdays. Students get full credit by submitting their work (doesn't have to be neat—will usually be very messy) on blackboard after class.

## Final Exam

The final homework will be cumulative, covering material from the entire semester, and will count as the final exam.

## Grade distribution

Below is a rough guide to how numerical grades will correspond to letter grades. I won't push the cutoffs up, but may push them a little bit down.

A	88-100%
B	75-87
C	63-74
D	50-62
F	< 50

## Academic Integrity

Students may discuss and work together on assignments, but all submitted work must be original and individual. Academic dishonesty, including all forms of cheating, plagiarism, and fabrication, is prohibited as stated in the WSU Handbook. (See <http://conduct.wsu.edu/>.)

## WSU Disability Statement

Reasonable accommodations are available for students with a documented disability. Please notify me the first week of class of any accommodations needed. Late notifications may cause requested accommodations to be unavailable. All accommodations must be approved through Disability Resource Center (DRC), Administration Annex 205, 335-1566.

## WSU Safety

For WSU's general safety statements, see <http://safetyplan.wsu.edu>.

For current safety alerts, see <http://alert.wsu.edu>.

For advice on dealing with emergencies, see <http://oem.wsu.edu/emergencies>.

## Course Outline

Week	material	chapter in textbook	Assignment
1	differential geometry review, covariant derivatives	2, 3	
2	curvature and geodesic deviation	3	1
3	symmetries and other math	3	2
4	Einstein field equations	4	3
5	physics in curved spacetime	4	4
6	Schwarzschild metric	5	5
7	Static black hole in other coordinates	5	6
8	Kerr solution; black hole properties	6	7
9	linearized gravity and gauges	7	8
10	gravitational waves: solutions and detection	7	9
11	gravitational waves: generation and feedback on sources	7	10
12	Robertson-Walker metric and the Friedmann equation (cosmology)	8	11
13	cosmological redshifts, distances, horizons	8	12
14	quantum field theory in curved spacetime	9	final exam