Physics 610: “General Relativity”  
(CRN 23242)  
Pre-requisite: Introductory Mechanics

Instructor:  
Prof. Tien-Tien Yu (she/her): tientien@uoregon.edu  
Office Hours: Tu 3:00pm-4:00pm WIL474 or https://uoregon.zoom.us/my/tientien.yu

Teaching Assistant:  
Joel Doss (he/they): jdoss@uoregon.edu  
Office Hours: Mon 3:00pm-4:00pm  
https://uoregon.zoom.us/j/96579921008?pwd=QUtvaFRMUTFmSkZiRjJFbXpUSGJCZz09

Logistics

When and Where: TuTh 10:00am - 11:50am in Willamette 147


Recommended Textbooks:


General Relativity, Robert M. Wald, ISBN: 978-0226870335 (even more advanced)

Overview:

This course part of a two-course sequence on General Relativity. This term will serve as an introduction to the concept of gravity as geometry. We will begin by motivating the need for General Relativity and culminate in the presentation of the Einstein equation, presenting some of the simplest solutions to the Einstein equation. We will stress the relevance of general relativity for physical phenomena and emphasize the connection to experiment and observation.
Course Objectives

Students will develop knowledge on the following topics:

- Space and Time in Newtonian physics and Special Relativity
- Curved Spacetimes
- Einstein’s equations and some general solutions
- Black holes
- Cosmological models
- Gravitational Waves

Assessment and Grading

Your course grade will be based on the following components:

- **Weekly Assignments.** [70%] These are traditional problem-sets.
- **Midterm Exam.** [15%] There will be 1 take-home midterm exam worth 25%.
- **Final Presentation.** [15%] At the end of the term, you will make a short presentation.

Letter Grade Interpretation:

- ≥ A- (Mastery): Vast majority of assignments done correctly and submitted on-time. Presentation is clear, well-organized, and questions are properly addressed.
- ≥ B- (Pass): Honest attempt made on all majority of assignments and submitted on-time. Presentation is coherent and organized, but some questions were not adequately addressed.
- ≤ C+ (Fail): Assignments submitted late and/or contains several incorrect problems. Presentation is unclear or disorganized and questions cannot be properly addressed.

Campus resources to support your learning:

**Instructional Accommodations:** The Accessible Education Center ([http://aec.uoregon.edu](http://aec.uoregon.edu)) exists to help students achieve access to educational resources. If there are aspects of the instruction or design of this course that result in barriers to your participation, please contact me as soon as possible so we may discuss your situation.
Counseling Center: Call anytime to speak with a therapist who can provide support and connect you with resources. Located on the 2nd Floor of the Health Center (541) 346-3227.

Policies:

Course load: Per UO policy, 1 credit hour is approximately 30 real hours of student work, both in and out of class. This is a 4-credit course, which corresponds to about 120 hours over the fall term or 12 hours per week that you spend on lecture + discussion, reading course materials, and asking questions. This number will vary from student-to-student, and week-by-week. However, if you find yourself spending significantly more time than this on the course, please contact the instructor.

Inclusivity: Open inquiry, freedom of expression, and respect for difference are fundamental to a comprehensive and dynamic education. We are committed to upholding these ideals by encouraging the exploration, engagement, and expression of divergent perspectives and diverse identities.

Don’t be a jerk: This course requires students to collaborate with one another; therefore, we must treat each other with respect in our constructive criticism. Bullying and trolling will not be tolerated by anyone in this course; the teaching staff reserves the right to punish misbehavior with zero credit on assignments or failure in the course.

Academic Integrity: All students are expected to complete assignments in a manner consistent with academic integrity. Academic dishonesty devalues the reputation of our institution, its faculty, its students, and the degrees we offer. Moreover, academic misconduct is particularly unfair for the students who do their work with integrity and honor. Students can find more complete information about the University of Oregon’s Policy on Academic Dishonesty in the University of Oregon Student Handbook. Suspected academic dishonesty will be reported.

Mandatory Reporter: I am a student-directed employee; my reporting obligations can be found here. Students experiencing any form of prohibited discrimination or harassment, including sex or gender-based violence, may seek information and resources at safe.uoregon.edu, respect.uoregon.edu, or investigations.uoregon.edu or contact the non-confidential Title IX office/Office of Civil Rights Compliance (541-346-3123), or Dean of Students offices (541-346-3216), or call the 24-7 hotline 541-346-SAFE for help. I am also a mandatory reporter of child abuse.
### Physics 610 - Tentative Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Day</th>
<th>Date</th>
<th>Lecture - Hartle Chpts</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>T</td>
<td>Jan 4</td>
<td>1-3</td>
<td>Introduction to gravity &amp; geometry</td>
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<tr>
<td></td>
<td>Th</td>
<td>Jan 6</td>
<td>4-5</td>
<td>Special relativity &amp; 4-vector notation</td>
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<tr>
<td>Week 2</td>
<td>T</td>
<td>Jan 11</td>
<td>5, cont.</td>
<td>Tensors and Dynamics</td>
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<tr>
<td></td>
<td>Th</td>
<td>Jan 13</td>
<td>6-7</td>
<td>Equivalence principle &amp; curved spacetime</td>
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<tr>
<td>Week 3</td>
<td>T</td>
<td>Jan 18</td>
<td>7-8</td>
<td>Geodesics</td>
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<tr>
<td></td>
<td>Th</td>
<td>Jan 20</td>
<td>9</td>
<td>Geometry outside a star</td>
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<tr>
<td>Week 4</td>
<td>T</td>
<td>Jan 25</td>
<td>12,</td>
<td>Black holes, take-home mid-term</td>
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<td></td>
<td>Th</td>
<td>Jan 27</td>
<td>13,</td>
<td>more Black holes</td>
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<tr>
<td>Week 5</td>
<td>T</td>
<td>Feb  1</td>
<td>20-21</td>
<td>Curvature and Einstein’s equation</td>
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<td></td>
<td>Th</td>
<td>Feb  3</td>
<td>21-22</td>
<td>More Curvature, solutions to Einstein’s eq.</td>
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<tr>
<td>Week 6</td>
<td>T</td>
<td>Feb  8</td>
<td>22</td>
<td>more solutions to Einstein’s eq.</td>
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<td></td>
<td>Th</td>
<td>Feb 10</td>
<td>16</td>
<td>Gravitational Waves</td>
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<tr>
<td>Week 7</td>
<td>T</td>
<td>Feb 15</td>
<td>23</td>
<td>more Gravitational Waves</td>
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<td></td>
<td>Th</td>
<td>Feb 17</td>
<td>17</td>
<td>Observable Universe</td>
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<td>Week 8</td>
<td>T</td>
<td>Feb 22</td>
<td>18</td>
<td>Cosmology</td>
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<td></td>
<td>Th</td>
<td>Feb 24</td>
<td>18, cont</td>
<td>more Cosmology</td>
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<tr>
<td>Week 9</td>
<td>T</td>
<td>Mar  1</td>
<td>special topics</td>
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<td>Th</td>
<td>Mar  3</td>
<td>special topics</td>
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<tr>
<td>Week 10</td>
<td>T</td>
<td>Mar  8</td>
<td>final projects</td>
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<td></td>
<td>Th</td>
<td>Mar 10</td>
<td>final projects</td>
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The given schedule is tentative; changes will be discussed in class.

**Important Dates:** ([academic calendar](http://example.com/calendar))

- Jan 8  Last day to drop without a “W”
- Jan 10 Last day to add a class
- Feb 20 Last day to withdraw (drop with a “W”) or change grading option to P/N
University COVID Policies

**Expectations for each other**
Eating and drinking in classrooms is not currently allowed at UO. We ask that class members step outside when they need to eat or drink, take medication, or anything else that necessitates taking off masks. Please feel free to do this whenever you need to—there is no need to ask permission around this. Students who may have mobility issues that make this guidance challenging should contact me.

In addition, being back in person may feel more challenging for some of us, for a variety of reasons. If you need to step outside of the room momentarily to take care of your own physical or mental needs, please feel warmly welcome to do so.

**Academic Disruption**
In the event of a campus emergency that disrupts academic activities, course requirements, deadlines, and grading percentages are subject to change. Information about changes in this course will be communicated as soon as possible by email, and on Canvas. If we are not able to meet face-to-face, students should immediately log onto Canvas and read any announcements and/or access alternative assignments. Students are also expected to continue coursework as outlined in this syllabus or other instructions on Canvas.

In the event that the instructor of this course has to quarantine, this course may be taught online during that time.

**COVID Containment Plan for Classes**
As the University of Oregon returns to in-person instruction, the key to keeping our community healthy and safe involves **prevention, containment, and support**. Here is information critical to how the UO is responding to COVID-19.

- **Prevention**: To prevent or reduce the spread of COVID-19 in classrooms and on campus, all students and employees must:
  - Comply with **vaccination policy**
  - Wear face coverings in all indoor spaces on UO campus
  - Complete weekly **testing** if not fully vaccinated or exempted
  - Wash hands frequently and practice social distancing when possible
  - Complete daily **self-checks**
  - Stay home/do not come to campus if feeling **symptomatic**
  - Complete the UO COVID-19 case and contact reporting form if you test positive or have been in close contact with a confirmed or presumptive case.

- **Containment**: If a student in class tests positive for COVID-19, all relevant classes will be notified via an email by the Corona Corps Care Team with instructions for students and staff based on their vaccination status. Specifically:
  - **Vaccinated and Asymptomatic students**: Quarantine not required, but daily self-monitoring before coming on campus is advised; sign up for testing through MAP 3-5 days after exposure if advised you are a contact.”
- **Unvaccinated or partially vaccinated students:** 14-day quarantine advised – do not come to class – and sign up for testing 3-5 days after notification through MAP, if asymptomatic, or through University Health Services (541-346-2770) or your primary care provider, if symptomatic.

- **Symptomatic students:** stay home (do not come to class/campus), complete the online case and contact form, and contact University Health Services (541-346-2770) or your primary care provider to arrange for immediate COVID-19 testing.

Students identified as a **close contacts** of a positive case will be contacted by the Corona Corps Care Team (541-346-2292).

- **Support:** The following resources are available to you as a student.
  - University Health Services or call (541) 346-2770
  - University Counseling Center or call (541) 346-3277 or (541) 346-3227 (after hrs.)
  - MAP Covid-19 Testing
  - Corona Corps or call (541) 346-2292
  - Academic Advising or call (541) 346-3211
  - Dean of Students or call (541)-346-3216

**Good Classroom Citizenship**

- Wear your **mask** and make sure it fits you well
- **Stay home** if you’re sick
- **Get to know your neighbors** in class, and let them know if you test positive
- Get tested regularly
- Watch for **signs and symptoms** with the daily symptom self-check
- **Wash your hands** frequently or use hand sanitizer

Complete the UO COVID-19 **case and contact reporting form** if you test positive or are a close contact of someone who tests positive.