PHYS 428/PHYS 628: Relativity

Spring 2023

Instructor: Dr. Peter A. Becker, Planetary Hall, room 251, 993-3619

Classroom: Exploratory Hall room 1004

Class Time: MW 9:00-10:15am

Required Text: "Introducing Einstein's Relativity" by D'Inverno

Additional printed material will be provided by the instructor.

The lectures will be presented live in the classroom on the large whiteboard in the room, and the class notes will not be published online. I may be able to livestream the lectures on Zoom, but unfortunately, I can't guarantee that you'll be able to see the complete whiteboard, so attendance at the lectures is mandatory unless you have a valid medical of family or work-related explanation for your absence.

There will be one in-class midterm exam and one final exam. The semester grades will be based on the two exams, combined withgrades on the weekly homework assignment, and class attendance and participation.

Lecture 1, 01/23/2023: Pages 13-19: Principles of special relativity

Lecture 2, 01/25/2023: Pages 20-21: Relativity of simultaneity

Lecture 3, 01/30/2023: Pages 22-27 Photon clock; time dilation; length contraction

Lecture 4, 02/01/2023: Pages 31-36: Lorentz transformation; spacetime interval; proper time

Lecture 5, 02/06/2023: Pages 37-42: Transformation of velocity; twin paradox; causality

Lecture 6, 02/08/2023: Pages 43-44: Doppler effect; aberration of radiation; redshift

Lecture 7, 02/13/2023: Pages 49-53: Relativistic mechanics; 4-vectors; 4-force, 4-acceleration

Lecture 8, 02/15/2023: Pages 54-58: Relativistic mass and energy

Lecture 9, 02/20/2023: Pages 65-67: Covariant and contravariant tensors in special relativity

Lecture 10, 02/22/2023: Pages 68-81: Tensors transformation rules

Lecture 11, 02/27/2023: Pages 85-89: Covariant and contravariant tensor gradients

Lecture 12, 03/01/2023: Pages 90-93: Affine connection; covariant differentiation

Lecture 13, 03/06/2023: Pages 94-99: Rieman tensor; affine flatness; parallel transport

Lecture 14, 03/08/2023: **MIDTERM EXAM**

Lecture 15, 03/13/2023: **Spring Break**

Lecture 16, 03/15/2023: **Spring Break**

Lecture 17, 03/20/2023: Pages 100-106: Metric tensor; curvature tensor

Lecture 18, 03/22/2023: Pages 135-141: Minkowski metric; affine connection

Lecture 19, 03/27/2023: Pages 148-151: Covariant formulation of relativistic mechanics

Lecture 20, 03/29/2023: Pages 153-161: Principle of covariance

Lecture 21, 04/03/2023: Pages 162-167: Principle of equivalence

Lecture 22, 04/05/2023: Pages 171-175: Vacuum field equations

Lecture 23, 04/10/2023: Pages 176-185: Full field equations of general relativity

Lecture 24, 04/12/2023: Pages 203-207: Energy momentum tensor; E&M in relativity

Lecture 25, 04/17/2023: Pages 321-327: Non-rotating black holes; Schwarzschild solution

Lecture 26, 04/19/2023: Pages 328-330: Static frames in Schwarzschild metric

Lecture 27, 04/24/2023: Pages 331-338: Applications of the Schwarzschild metric

Lecture 28, 04/26/2023: Pages 367-373: Rotating black holes; Kerr solution

Lecture 29, 05/01/2023: Pages 374-380: Locally non-rotating frames in Kerr metric

Lecture 30, 05/03/2023: Pages 381-394: Applications of the Kerr metric

FINAL EXAM, 05/15/2023: 7:30am - 10:15am