

PHYS 200j

Special Relativity using Spacetime Trigonometry

Mount Holyoke College - January 2009

Meeting Times:

Kendade 305 10:00a – 12:00p,

8 class days: Jan 12-15 (M-Th), Jan 20-23 (Tu-F)

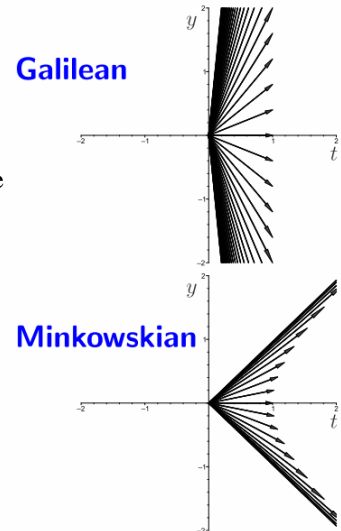
Instructor: Rob Salgado Visiting Assistant Professor of Physics Office: Kendade 215 Voice: (413)-538-2816	Email (the best way to contact me): rsalgado@mtholyoke.edu Instant-Messengers: AOL, MSN, Yahoo: mhcphyrob (do <i>not</i> email here)	Office hours: after class: 12p-1p
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Catalog Description:

PHYS 200j – Special Relativity using Spacetime Trigonometry (2 credits)

This course is an introduction to Galilean and Special Relativity. Physical intuition is developed with a new approach using the geometry and trigonometry of spacetime diagrams, together with thought-experiments. Topics include: Kinematics (proper-time, velocity, and acceleration), Dynamics (energy and momentum), and Spacetime Structure (light cones and causality). Time permitting, we may offer brief introductions to tensors and to the relativistic formulation of Electromagnetism. The first part of each class meeting is mainly a lecture presentation of the various topics. The second part is a problem-solving session for treating standard textbook problems with these new methods.

[Prerequisite: High school geometry and trigonometry; introductory physics and calculus would be helpful.]



Required Textbook: *none*

Course Goals:

- Review of Euclidean Geometry.
- Careful introduction to Galilean Relativity using Galilean spacetime geometry (using your Euclidean intuition) and your everyday physical intuition.
- Careful introduction to Special Relativity using Minkowski spacetime geometry (hopefully made easier using your Euclidean and Galilean intuition).
- Develop trigonometric methods to solve textbook problems in relativity.

Electronic Materials:

I will maintain a website (for now: <http://www.mtholyoke.edu/courses/rsalgado/200j/>) that links to homework assignments, solutions, electronic-whiteboard notes, and handouts---possibly using *Ella*.

Grades are based on:

ON-TIME ATTENDANCE
 CLASS PARTICIPATION (including working in small-groups)
 HOMEWORK ASSIGNMENTS

Ambitious Sequence of PHYS 200j topics: (*Physical concepts* in *italics*. The symbol * denotes an advanced topic.)

1. **Introduction and Motivation for this course; *Relativity, Spacetime, Spacetime Geometry***
2. **Circle (*Metric*) and Radius (*Inertial Observers and Proper Time*), Perpendicular (*Space and Time*), *Spatial-Distance*, Euclid's Postulates (*Causality-and-Simultaneity*), Angles (*Rapidity*), **Trigonometric Functions (*Relativistic factors*)****
3. **Trigonometric Functions and Identities, Rotations* (*Boost Transformations*), Right-Triangles, Projection (*Time Dilation*), Slope (*Spatial-Velocity*)**
4. **Eigenvectors* (*"Absolute" Quantities*), Relative-Slope (*Relative-Spatial-Velocity*), Parallel and Perpendicular, Distance between parallel lines (*Spatial-Length and Length Contraction*)**
5. **Law of Cosines and the Triangle-Inequality (*Clock Effect/Twin Paradox*), Law of Sines, *Doppler Effect***
6. **Curvature of a curve (*Acceleration*), *Energy-and-Momentum*, "*E=mc²*"**
7. ***Light: Maxwell-Equations**, *Light-Clock*, *Light-Cones*, *Radar-Measurements*, **k-calculus****
8. **Spacetime Curvature* (*General Relativity* and Black Holes**)**