**Physics 3725**

**Special and General Relativity**

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lectures: 10:00-10:59, Monday, Wednesday, Friday, 106 Allen Hall

**Required Text:** *An Introduction to General Relativity, Spacetime, and Geometry*, Sean M. Carroll.

**Suggested Texts** (including the second term)

* W. Rindler, *Essential Relativity*
* R. Wald, *General Relativity* [$27.95 at [Barnes and Noble](http://www.bn.com)]
* A.R. Liddle and D.H. Lyth, *Cosmological Inflation and Large-Scale Structure*
* E.W. Kolb and M.S. Turner, *The Early Universe*
* J.L. Synge and A. Schild, *Tensor Calculus* [$12.55 at [Barnes and Noble](http://www.bn.com)]
* J. Foster and D. Nightingale, *A Short Course in General Relativity* [$29.95 at [Barnes and Noble](http://www.bn.com)]
* M. Ludvigsen, *General Relativity, a Geometric Approach* [$27.95 at [Barnes and Noble](http://www.bn.com)]
* S. Weinberg, *Cosmology*

**Content:**

* 1.0 Introduction and Motivation. ficticious forces & gravity,
* 1.1 Special Relativity. inertial frames of reference, Fizeau and Micelson-Morley experiments, Lorentz transformation, Minkoswki diagrams, time dialtion, length contraction, velocity addition, Doppler effect
* 1.2 Simple Tensors. 4-vectors, contravariant and covariant tensors, the metric, the Lorentz group, Lorentz algebra, Cartesian tensors,
* 1.3 Relativistic Motion. proper time, 4-momentum, 4-force, lagrangian
* 1.4 Classical Field Theory. field lagrangian, equations of motion, EM, canonical energy-momnetum tensor, symmetric energy-momentum tensor, dust, perfect fluid, a note on the covariance of A(mu) and the connection to gravity.
* 2.0 Mathematical Interlude.
* 2.1 tangent space, tangent bundle, dula vectors, manifolds, coordinate basis, one-forms, local inertial coordinates, causality, tensor densities, differential forms, Hodge duality, integration.
* 3.0 Curvature
* 3.1 Christoffel symbols, covariant derivative, parallel transport and geodesics, affine parameters
* 3.2 The Expanding Universe, cosmological red shift,
* 3.3 The Riemann Curvature Tensor. Ricci tenosr,
* 3.4 Symmetries and Killing Vectors.
* 3.5 Maximally Symmetric Spaces
* 3.6 Geodesic Deviation
* 4.0 Gravity
* 4.1 Physics in Curved Spacetime
* 4.2 Einsteins Equations. the Hilbert action, the cosmological constant, energy conditions
* 5.0 The Schwartzschild Metric. solution to the field equations, black holes, deviation of light.
* marking scheme: 70% + 30% take home exam
* [Reading List](http://fafnir.phyast.pitt.edu/GR/phys3725.html)
* [Deep Quote](http://fafnir.phyast.pitt.edu/GR/bondi.html)
* [CMB stuff](http://background.uchicago.edu/%7Ewhu/)
* [Werner Israel](http://www.science.ca/scientists/scientistprofile.php?pID=9)
* [Stationary Black Holes: Uniqueness and Beyond](http://www.livingreviews.org/Articles/Volume1/1998-6heusler/)

**Assignments**

* [asst 1](http://fafnir.phyast.pitt.edu/GR/asst1.ps)
* [asst 2](http://fafnir.phyast.pitt.edu/GR/asst2.ps)
* [asst 3](http://fafnir.phyast.pitt.edu/GR/asst3.pdf)