Physics 751 – General Relativity – Spring 2019

Class meetings: M, W, F at 10:00 – 10:50 in 227 La Tourette

Prof. S. Martin 214 La Tourette spmartin@niu.edu

Office hours: M, T, W, F 11:00 – 11:50 (or whenever you can find me)

Class home page: http://www.niu.edu/spmartin/phys751

Textbook: *Spacetime and Geometry: An Introduction to General Relativity* by Sean M. Carroll. Pearson Addison-Wesley, 2004. ISBN-13: 978-0805387322

Grading: Based 100% on homework. Late penalty policy: 10% off for each day after the due date, for up to 5 days; 100% off for > 5 days late. I prefer homeworks to be turned in at the end of class, but they are considered on time if received by 4:30 PM on the due date. You are encouraged to consult with each other on the homework. However, everything you turn in must be your own work. Do not turn in anything that you have copied, or anything that you do not fully understand. Grades will be assigned according to your numerical score as a percentage, with each homework set weighted equally. The low cutoff for each grade is as follows:

A 90%,	A– 87%,	B+ 84%,	B 80%,
B– 75%,	C+ 70%,	C 65%,	D 55%.

No C– or D+ or D– grade will be assigned. I reserve the right to amend the above grading scale to be more lenient, but it is guaranteed not be made more strict.

Topics to be covered:

- Special relativity and flat spacetime
  - Space, time, and Lorentz transformations
  - Vectors, dual vectors, and tensors
  - Maxwell's equations
  - Energy and momentum
- Manifolds
  - Equivalence principle
  - Gravity as geometry
  - Definition and properties of manifolds
  - Vectors, dual vectors, and tensors on manifolds
  - Metrics
  - Tensor densities and integration
  - Causality
- Curvature
  - Connections, Christoffel symbols, and covariant derivatives
  - Parallel transport and geodesics
  - Riemann curvature tensor
  - Ricci tensor, Ricci scalar, and Weyl tensor

  - Symmetries, isometries, and Killing vectors

- Gravity in curved spacetime
  - The equivalence principle
  - Einstein's equation
  - Einstein-Hilbert action
  - Cosmological constant

- Black hole solutions
  - Schwarzschild metric
  - Geodesics and experimental tests
  - Eddington-Finkelstein and Kruskal coordinates
  - Event horizons and conformal diagrams
  - Eternal and astrophysical black holes
  - Hawking radiation and black hole evaporation
  - Black holes with charge and/or angular momentum

- Cosmology
  - Isotropic and homogeneous universes
  - Robertson-Walker metrics
  - Open, closed and flat universes
  - deSitter and anti-deSitter spaces
  - The scale factor and the Friedmann equation
  - Redshift and distance measurements
  - Observed parameters of our universe
  - The flatness and horizon problems
  - Inflation

- Linearized gravity
  - Perturbations to the flat Minkowski metric
  - Gauge transformations and gauge choices
  - Newtonian fields
  - Gravitational waves

Accessibility Statement: Northern Illinois University is committed to providing an accessible educational environment in collaboration with the Disability Resource Center (DRC). If you need an accommodation for this class, please contact the DRC as soon as possible. The DRC coordinates accommodations for students with disabilities. It is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 or drc@niu.edu. Also, please contact me privately as soon as possible so we can discuss your accommodations. Please note that you will not be required to disclose your disability, only your accommodations. The sooner you let me know your needs, the sooner I can assist you in achieving your learning goals in this course.