General Relativity

1. Mathematics of General Relativity by James Cook
    1. Course Overview
    2. Spacetime or Timespace
    3. Index Calculations, Summation, an Example from Vector Algebra
    4. Lorentz Transformations and Euclidean Isometries
    5. Newtonian Space and Minkowski Space
    6. Tensor Calculations in Minkowski Space and More
    7. 4-Vectors and Physics in Special Relativity
    8. Maxwell's Equations
    9. Lagrangian Mechanics
    10. Classical Field Theory
    11. (a) Equivalence Principle Sketched
        (b) On Calculus on Manifolds, a Lightning Tour
    12. Metric on Spacetime
    13. Overview of Curvature and Einstein's Field Equations
    14. (a) Covariant Derivatives and Curvature from Frankel
        (b) Covariant Derivatives and Curvature from Carroll
    15. Variational Calculus and Geodesics
    16. Einstein's Equations and a Word on Generalizations of GR
    17. Schwarzschild Solution
    18. Gravitational Waves
    19. Cosmological Models
    20. (a) Tetrad Method, Lorentzian frames
        (b) Calculating Curvature via Tetrad Formalism, Future Reading

2. General relativity by Scott A. Hughes

1. Introduction and the Geometric Viewpoint on Physics
2. Introduction to Tensors
3. Tensors Continued
4. Volumes and Volume Elements Conservation Laws
5. The Stress Energy Tensor and the Christoffel Symbol
6. The Principle of Equivalence
7. Principle of Equivalence Continued Parallel Transport
8. Lie Transport, Killing Vectors, Tensor Densities
9. Geodesics
10. Spacetime Curvature
11. More on Spacetime Curvature
12. The Einstein Field Equation
13. The Einstein Field Equation Variant Derivation
14. Linearized Gravity I: Principles and Static Limit
15. Linearized Gravity II: Dynamic Sources.
16. Gravitational Radiation I
17. Gravitational Radiation II
18. Cosmology I
19. Cosmology II
20. Spherical Compact Sources I
21. Spherical Compact Sources II
22. Black Holes I
23. Black Holes II

3. The WE-Heraeus International Winter School on Gravity and Light by Frederic P. Schuller et al.

3.1 Central Lecture Course

1. Lecture 1: Topology
2. Lecture 2: Topological Manifolds
3. Lecture 3: Multilinear Algebra
4. Lecture 4: Differentiable Manifolds
5. Lecture 5: Tangent Spaces
6. Lecture 6: Fields
7. Lecture 7: Connections
8. Lecture 8: Parallel Transport & Curvature
9. Lecture 9: Newtonian spacetime is curved!
10. Lecture 10: Metric Manifolds
11. Lecture 11: Symmetry
12. Lecture 12: Integration on manifolds
13. Lecture 13: Spacetime
14. Lecture 14: Matter
15. Lecture 15: Einstein Gravity
16. Lecture 16: Optical Geometry I
17. Lecture 17: Optical Geometry II
18. Lecture 18: Canonical Formulation of GR I
19. Lecture 19: Canonical Formulation of GR II
20. Lecture 20: Cosmology - The Early Epoch
21. Lecture 21: Cosmology - The Late Epoch
22. Lecture 22: Black Holes

23. Lecture 23: Penrose Diagrams
24. Lecture 24: Perturbation Theory I
25. Lecture 25: Perturbation Theory II
26. Lecture 26: How Quantizable Matter Gravitates
27. Lecture 27: Sources of Gravitational Waves
28. Lecture 28: How to Detect Gravitational Waves

3.2 Tutorials A & B

1. Tutorial 1: Topology
2. Tutorial 2: Topological Manifolds
3. Tutorial 3: Multilinear Algebra
4. Tutorial 4: Differentiable Manifolds
5. Tutorial 5: Tangent Spaces
6. Tutorial 6: Fields
7. Tutorial 7: Connections
8. Tutorial 8: Parallel Transport Curvatur
9. Tutorial 9 & 10: Metric Manifolds
10. Tutorial 11: Symmetries
11. Tutorial 12: Integration
12. Tutorial 13: Schwarzschild Spacetime
13. Tutorial 15: Cosmology
14. Tutorial 16: Diagrams

3.3 Evening Lectures

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