



Course Outline

Part I. Special Relativity

- **Chapter 1**
From relativistic particles to compact stars
- **Chapter 2**
Vectors
One-forms
Dual basis
Tensors
Covariant and contravariant quantities
- **Chapter 3: Principles of Special Relativity**
Inertial frames
The principle of relativity
Lorentz covariance
Lorentz transformation and four vectors
Space-time diagrams
Time dilation, length contraction, twin paradox
Relativity of simultaneity
Addition of velocities
Acceleration in special relativity
- **Chapter 4: Special Relativistic Mechanics**
Special relativistic kinematics
Special relativistic dynamics
Relativistic variational principle
- **Chapter 5: Applications**
Maxwell equations
Relativistic quantum mechanics
Relativistic field theory

Part II. General Relativity

- **Chapter 6:**
Acceleration
Curved Space-Time
Gravity

Geodesic equation

- **Chapter 7: Einstein's Field Equation**

- Energy-momentum tensor

- Covariant differentiation

- Parallel transport

- Riemann curvature tensor, Ricci tensor, scalar curvature

- The cosmological constant

- Classical limit of Einstein's field equation

- **Chapter 8: Relativistic Stars**

- Equation of state

- Neutron stars, white dwarfs, black holes

- Rotation in General Relativity

- **Chapter 9: Classical Tests of General Relativity**

- Perihelion motion of Mercury

- Bending of light

- **Chapter 10: Cosmological Models and the Universe**

- Robertson-Walker metric

- Gravitational radiation