PHY407/SE315 - SPECIAL & GENERAL RELATIVITY
2025-26-I (odd) semester

Course Instructor: Nilay Kundu (email - nilayhep(at)iitk.ac.in)

- **Aim:** The aim of this course is to offer an introduction to general relativity. We will start with the Special Theory of Relativity at an advanced level (using the techniques of Lorentz covariant four-vector notation). This will be followed by topics in General Relativity. Application to cosmology will be covered if time permits.
- **Pre-requisite:** Prior exposure to an introductory course on Special Theory of Relativity (at the level of PHY226B) will be desired and useful.
- **Plan of the course:** The following topics will be covered in the course:
  1. *Special Theory of Relativity:* Lorentz transformations; representations of the Lorentz group and SL(2, C); 4-vector notation, transformation laws for velocity, momentum, energy; mass-energy equivalence; force equations, kinematics of decays and collisions.
  2. *General Relativity:* Introduction to General Relativity; The principle of equivalence; Introduction to differential geometry and Riemannian geometry: Vector fields, Parallel transport and Lie derivatives; Symmetries and isometries: Killing vectors; Space-time curvature and stress-energy tensors; Gravitational field equations: Einstein's equations; Geodesics and particle trajectories; Introduction to black holes: Schwarzchild solution in different coordinates, event horizon, rotating and charged black holes.
  3. *Basic Introduction to cosmology:* FRW metric; cosmological expansion (if time permits)
- **References:** A few recommended textbooks which will cover the course material, are as follows
  1. *Introduction to Special Relativity* by Robert Resnick
  2. *Classical Mechanics* by Goldstein,
  3. *Space-time and Geometry* by Sean Caroll,
  4. *Classical Theory of Fields* by Landau and Lifshitz,
  5. *An introduction to Einstein's General Relativity* by James Hartle,
  6. *Introducing Einstein's Relativity* by Ray d'Inverno
  7. *Einstein Gravity in a Nutshell* by A. Zee
  8. *Cosmology* by Steven Weinberg

  Additional reference materials will be announced in the class.
- **Grading/Evaluation Policy:** Grading will be based on
  (a) Assignments + class tests/Quiz, (weightage - $20\% - 30\%$),
  (b) Mid-semester and end-semester examinations, (weightage - $35\% - 40\%$ each)
  Exact weitage will be announced in the class.
- **Attendance policy:** There will be no weightage of attendance in final grades. However, students with irregular attendance without prior notice may be deregistered from the course following institute policy.