Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD516	**Theory of Relativity**	3	0	0	3

Prerequisite: Classical Mechanics, Electrodynamics

Course Objective

The objective of the course is

- To provide a foundation for more advanced studies of general relativity to the beginners or to the curious students of any discipline other than physics;
- To motivate students to choose a career in related areas of physics;
- To prepare a base for an ambitious physics student who wants to go to advanced studies or research in relevant fields.

Learning Outcomes

Upon successful completion of this course, students will:

- Able to understand the theoretical framework and experimental necessity of Einstein's theory of general relativity;
- Eligible for higher studies in Astronomy and Astrophysics, Gravity, Cosmology, String Theory and various related areas.
- will be familiar with the basic principles of general relativity and physics in curved space-time;

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Special theory of relativity**: Empirical evidence for the constancy of c, frames of reference; Minkowski space and four vectors, concept of four-velocity, four acceleration and higher rank tensors, Lorentz transformations, world lines, Relativistic Mechanics of Mass Points, relativity of simultaneity; twin and other paradoxes, transformation laws for velocity, momentum, energy; mass-energy equivalence; force equations,	9	At the end of this unit students should know the consequences of the modification of classical Mechanics for Relativistic speeds. They should learn force, energy momentum relationship.
2	**Relativistic formulation of electrodynamics:** current four vector, Field-Strength tensor, Maxwell equations in covariant form, gauge invariance and four-potential, Energy-momentum tensor.	9	Learn to use laws of electrodynamics in relativistic regime.
3	**General Theory of Relativity:** Foundations of general relativity, Riemannian geometry of Euclidean signature manifolds, principle of equivalence; Mach's principle, Christoffel symbols, Relation between matric and affine connection. geodesics and particle trajectories,	9	Students will master the equivalence principle and have a good knowledge of how this leads to a geometric description of gravity, in the form of the general theory of gravity.
4	**Principle of General Covariance :** Tensors and their transformations, Covarinat differentiation, Curvature tensor, general properties of the Riemann tensor.	9	Demonstrate understanding of the mathematics underpinning manifolds, tensors, metrics, geodesics and the Riemann tensor; tensor calculus on Riemannian manifolds.
5	**Einstein's Field equations:** Tests of Einstein's theory, Schwarzschild and Kerr space-time	6	Learn to solve the Einstein equations for simple forms of the stress-energy tensor;
	Total	**42**	

Text Books:

1. Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, Steven Weinberg, Wiley, 2013.
2. A first course in general relativity by Bernard F. Schutz, Cambridge, 2009.

Reference Books:

1. The Physical Universe, Shu, F., University of California, 1982.
2. Gravity: Introduction to Einstein's General Relativity, Hartle, J. B., Pearson Education, 2003.
3. Spacetime and Geometry: An Introduction to General Relativity, Sean Caroll, Pearson, 2003.