SS862 GENERAL THEORY OF RELATIVITY 3-1-0-4

Course objectives:

The aim of the course is to have a comprehensive physical idea and mathematical understanding of General theory of Relativity and its applications in fields like Cosmology and Astrophysics.

UNIT 1: Introduction

Special Theory of Relativity, Four vectors, Minkowskispace time, Relativistic Dynamics, Action for the relativistic free particle. The principle of equivalence, Principle of General covariance, Prelude to General Theory of Relativity – historical developments.

UNIT 2: Tensor Analysis

Riemannian space, Curvilinear coordinates, Tensors, Affine connection, Covariant derivative, Geodesics, Riemann-Christoffel curvature tensor, Bianchi identities, Ricci Tensor, Curvature Scalar.

UNIT 3: Einstein Field Equations

Gravity and Geometry,Energy-momentum tensor, Bianchi identities, Einstein tensor, The vacuum Einstein equations, Einstein-Hilbert Action. Motion in Gravitational Field, Weak Gravitational Field.

UNIT 4:Schwartzchild Solution and Tests of General Theory of Relativity

Centrally symmetric Gravitational Field,Static spherically symmetric space-time, Schwartzchild Solutions, Radial Freefall, Lighcones.

Tests of General Theory of Relativity:Perihelion of Mercury, Deflection of light.

UNIT 5: Black Holes and Cosmology

Relativistic Stellar star structure, Gravitational Collapse, Black Holes.

Cosmology: Homogeneity and Isotropy of the Universe, Friedmann– Robertson–Walker metric, Cosmological solutions.

Text Books:

1. Ashok Das, *Lectures on Gravitation,* World Scientific, 2013.

2. Steven Weinberg, *Gravitation and Cosmology: Principles and Applications of theGeneral Theory of Relativity,* Wiley India, 2008.

3. ØyvindGrøn, SigbjornHervik,*Einstein's general theory of relativity: with modern applications in cosmology,* Springer,2002.

Reference Books:

1. Landau &Lifshitz, *Classical Field Theory*, University Science Books, 1E, 2004

2. C. W. Misner, K. S. Thorne and J. A. Wheeler,*Gravitation*, Princeton Univ Press, 2017.

3. A. Einstein, *Relativity: The Special and the General Theory*, General Press, 2013.

Course Outcomes:

After the completion of the course student is expected to:

CO1: Use differential geometry to describe the properties of a curved space and demonstrate specialised analytical skills and techniques necessary to carry out the study of special theory of relativity using tensor calculus.

CO2: Understand Einstein's field equations, account for the physical interpretation of its components, and prove that Newton's theory of gravity is recovered in the non-relativistic limit.

CO3: Study of solution of Einstein field equation in the case of static, spherically symmetric gravitational field. Study of particle trajectories and tests of GTR.

CO4: Apply the mathematical and physical ideas of the theory of general relativity for the study of various systems in astrophysics and cosmology

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