

Course Code	Course Name	Credits
26PH108	GENERAL RELATIVISTIC	04

Course Objectives

- To familiarize students with special relativity
- To make student aware of astronomical phenomena like black hole, solar system etc.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Understand the various theories related to special relativity.
- Understand the different phenomenon related to gravity and cosmology
- Acquire the knowledge of Einstein's equation of relativity

Unit 1 - Theory of Relativity (12 Hrs.)

Special Relativity, Oblique Axes, Curvilinear Coordinates, Non-tensors and the Quotient theorem, Curved Space, Parallel Displacement, Christoffel Symbols, Geodesics, The stationary Property of Geodesics, Covariant Differentiation, The Curvature tensor, The Condition for Flat Space, The Bianci Relations.

Unit 2 – Laws of Relativity (12 Hrs.)

The Ricci Tensor, Einstein's Law of Gravitation, The Newtonian Approximation, Tensor Densities, Gauss and Stokes Theorem, Harmonic Coordinates, The Electromagnetic Field, Modification of Einstein's Equations by presence of Matter, The Material Energy tensor, The Gravitational Action Principle.

Unit 3 - Black Holes (12 Hrs.)

Schwarzschild Geometry, Gravitational Red shift - Particle Orbits: Precession of the Perihelion of Mercury, Light Ray Orbits: Deflection and time Delay of Light (Gravitational Lensing), Solar System Tests of General Relativity, Gravitational Collapse to a Black Hole, Astrophysical Black Holes.

Unit 4 – Gravitational Waves & Cosmology (12 Hrs.)

Linearized Gravitational Waves, Energy, Polarization - Detecting Gravitational Waves, Interferometers, Homogeneous and Isotropic Spacetimes: Expansion of the Universe, Cosmological Redshift, Matter, Radiation, Vacuum Energies: Evolution of FRW Models.

Unit 5 - Einstein Equations (12 Hrs.)

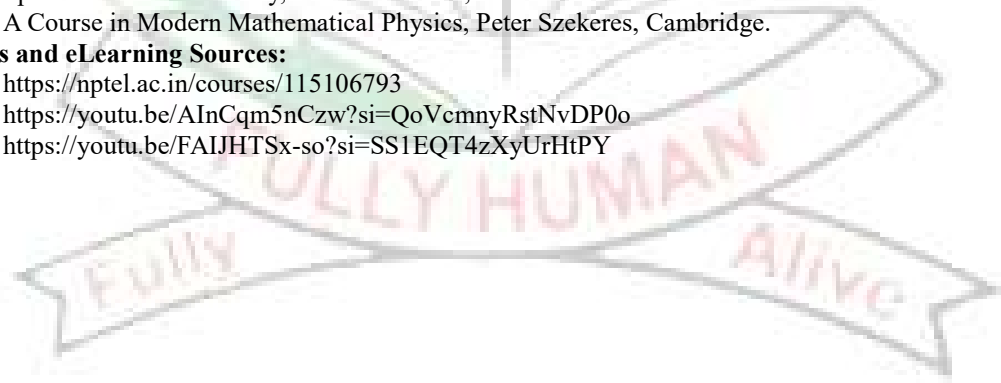
Tensors, Covariant Derivatives - Tidal Gravitational Forces, Riemann Curvature, Energy Momentum Conservation, Einstein Field Equations, Newtonian Limit, Applications: Production of Weak Gravitational Waves, Quadrupole Formula, Gravitational Radiation from Binary Pulsars.

Reference Books:

1. A First Course in General Relativity, 2 e, Bernard Schutz, Cambridge.
2. Space-time and Geometry, Sean M. Carroll, Pearson.
3. A Course in Modern Mathematical Physics, Peter Szekeres, Cambridge.

Websites and eLearning Sources:

1. <https://nptel.ac.in/courses/115106793>
2. <https://youtu.be/AInCqm5nCzw?si=QoVcmnyRstNvDP0o>
3. <https://youtu.be/FAIJHTSx-so?si=SS1EQT4zXyUrHtPY>



COs and Bloom's Taxonomy Mapping – 26PH108

Course Outcomes	On completing U.G. program the students will be able to	BTL
CO1	Recall and describe key concepts, equations, and principles of the Theory of Relativity, including the laws of gravitation, tensor calculus, and key properties of black holes.	K1
CO2	Explain the underlying principles of special and general relativity, including the concepts of spacetime, curvature, and the effects of gravity on light.	K2
CO3	Apply mathematical techniques and theoretical models to solve problems related to gravitational waves, black hole dynamics, and cosmological phenomena.	K3
CO4	Analyze experimental data related to gravitational phenomena and assess the validity of experimental methods used in the detection of gravitational waves.	K4
CO5	Critically evaluate existing scientific literature and propose innovative theoretical models or experimental setups to address current challenges in gravitational physics.	K5, K6

BTL K1 and K2 – remembering and understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH108

Course Outcomes	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)						Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.50
CO2	3	2	2	1	1	1	3	3	2	1	1	1	1.75
CO3	2	3	3	2	1	2	1	2	3	2	1	2	2.00
CO4	2	3	3	1	1	2	1	2	3	2	2	2	2.00
CO5	2	3	2	2	1	3	1	2	2	3	3	3	2.25
Total													1.90

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

