SECOND SEMESTER 2015-2016

Course Handout

Date:05/01/2016

Course Number : PHY F415

Course Title : GENERAL THEORY OF RELATIVITY AND COSMOLOGY

Instructor-in-Charge : TAPOMOY GUHA SARKAR

Scope & Objective of the Course:

This course aims to expose the students to the basics of General Theory of Relativity and Cosmology.

A knowledge of basic mechanics is assumed.

Text Book:

T: Gravity An Introduction to Einstein's General Relativity, James B Hartle , Addison Wesley.

Reference Books:

R1: Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, Steven Weinberg, John Wiley.

R2: A First Course in General Relativity, Bernard F. Schutz, Cambridge University Press.

Course Plan:

Save Paper. Save Trees. Save the World.

innovate achieve lead

Please Do Not Print Unless Necessary

Lecture Number	Learning Objectives	Topics to be Covered	Reference
1-4 (4)	Review of Special Theory of Relativity (STR)	Postulates of STR. Geometric formulation, Spacetime diagrams, Lorentz transformation. Minkowski metric. Relativistic kinematics, Relativistic dynamics, Newtonian relativity. Need for a geometric theory of gravity	REVIEW T: CHAPTER 3, 4, 5, 6
5-7 (3)	Introduction to differential Geometry. The aim is to train the students in geometry	Description of physics on a manifold, Coordinates and coordinate transformations. Structures on the manifold, Vectors and tensors on smooth manifold. Symmetries and Killing equation	CLASS NOTES T: CHAPTER 7
8-11 (4)	To understand the notion Geodesics as extremal paths	Parallel transport, Covariant Derivative and Affine connection. Metric tensor and its properties, relation with the affine connection Geodesic equation and its solutions	T: CHAPTER 8
12-16 (5)	The notion of Curvature is to be introduced.	The Riemann Curvature tensor and its properties. Relation of the Riemann to the metric tensor. Ricci tensor, Flows and Raychaudhuri equation.	CLASS NOTES T: CHAPTER 21
17-20 (4)	Einstein's field equations	Matter fields and energy momentum tensor. Einstein's equation from variational principle. Newtonian limit. Linearized solutions and gravitational waves and detection experiments.	T; CHAPTER 22
21 - 23(3)	Spherical symmetry and Schwarzschild solution	Trajectories in Schwarzschild spacetime. The r = 2M surface and Black Holes.	T: CHAPER 9 CLASS NOTES
24-26 (3)	Tests of Relativity	Bending of Light, Perihelion precession and gravitational redshift	T: CHAPER 10
27- 28 (2)	Cosmological principle (Homogeneous and isotropic Universe)	Homogeneous and isotropic Universe. Evidences and cosmological probe. Expanding Universe and Hubble's Law.	T: CHAPTER 17
29 - 33(5)	FRW Universe	The Big Bang theory and setting up of coordinate system. FRW metric as a solution Einstein's equation. Models of the	T: CHAPTER 18

		Universe. Distances in cosmology.	
33 - 34(2)	Composition of the Universe	Baryonic matter, Radiation , Dark matter, Dark Energy	CLASS NOTES
35 -39(3)	Thermal History of the Universe	The CMBR. Theory of CMBR. Observational probes. Hot big bang theory and decoupling of standard model particles. Cosmological Neutrino background. Big bang nucleosynthesis	CLASS NOTES
40-42 (3)	Introduction to structure formation	Inhomogeneous Universe. Cosmological perturbations (elementary). Jean's instability.	CLASS NOTES

Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage(%)	Date, Time & Venue	Nature of Component
1	Midterm	90 mins.	30	16/3 2:00 -3:30 PM	Closed Book
3	Tutorials/Assignments		25		Open Book/ Take home
4	Comprehensive Exam	3 hours.	45	9/5 FN	Closed Book + Open Book

Chamber Consultation Hour: To be announced in the class.

Notices: Notices and solutions will be displayed only on PHYSICS/FDIII notice board.

Make-up Policy [STRICT]No Make-ups for tutorial tests. Make up for regular tests will be given only to genuine cases, *i.e.* (i) Sickness leading to *hospitalization*, (ii) out-of-station with prior *intimation to/permission from* the IC.

Instructor-in-Charge