BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE -PILANI, K K BIRLA GOA CAMPUS

INSTRUCTION DIVISION

Second Semester 2024-2025

Course Handout

Date: 06.01.2025

Course No. : PHY F315
Course Title : Theory of Relativity (ToR)
Instructors : Indrakshi Raychowdhury **(I.C.)**

Course Description:

This course aims at developing the consequences of Einstein's principle of special relativity. This includes the idea of dealing with time as a coordinate similar to spatial ones, the consequence of physics being relativistic: phenomena of length-contraction and time-dilations. The symmetry transformation given by Lorentz transformations and the mathematical structure of this symmetry operation will be discussed in detail. Special emphasis will be on understanding relativistic kinematics - understanding electricity and magnetism on a unified footing. Relativistic phenomena in particle physics, such as particle decay or collisions of relativistic particles will be discussed.

Moreover, some mathematical techniques including tensor manipulations and Lie groups will be developed along the development of the course.

At least a couple of lectures towards the end of the course will be spent on understanding the general principle of relativity, from the point of view of incorporating laws of gravity in the framework of the principle of covariance.

Course Outcome:

By the end of the course, students should:

1) be able to explain the need for special relativity,
2) have an analytical grip on the concept of Lorentz transformation,
3) be able to calculate measurements made by differently boosted observers,
4) Explain relativistic physics
5) Explain electromagnetism, relativistic collisions of particles

Text Books:

T1. D. Kleppner and R. Kolenkow, An Introduction to Mechanics, 2nd

Edition, Cambridge University Press, New Delhi, 2021.

Reference Books:

R1. Landau & Lifshitz, vol 2, The classical theory of fields
R2. David Tong's lecture note: https://www.damtp.cam.ac.uk/user/tong/relativity/seven.pdf

Course Plan:

Serial No.	Topic	Duration	Content	References
1	Introduction to the principle of relativity	Week 1	Gallilean relativity, Principle of reality: postulates, Einstein's special theory of relativity	TB: Ch.11 R1: Ch 1 R2
2	Lorentz Transformation	Weeks 2-4	The transformation compatible with Einstein's relativity; consequences/relativistic physics: Causality, simultaneity, time dilation, length contraction	TB: Ch.11 R1: Ch 1 R2
3	Lorentz Group	Weeks 5-6	Geometry of Space-time-rotation, boosts.	Class notes
4	Relativistic Kinematics	Week 7-10	Proper time, 4-velocity, 4-momentum, Newton's law meets relativity, electromagnetism	TB; R1, R2
5	Particle decay/ collisions	Weeks 11-12	Relativistic phenomenon in particle physics.	TB R1, R2, classnotes
6	General Relativity	Week 13	Introduction to GR	classnotes

- Assignments will be given each alternate week on Fridays, which is to be returned by the deadline of the following Monday at 11:59 pm at the box kept outside IC's office.

Course Page: Quanta AWS

The announcements and details of the course will be posted here.

Lecture Hours:

Tuesdays: 7:00 PM - 8:30 PM
Saturdays: 9:00 AM - 10:00 AM

Evaluation Scheme:

Sr. No.	Evaluation Component	Weightage (%)	Schedule	Type
1	Comprehensive Exam	35	TBA	Closed book
2	Mid-semester Examination	30	TBA	Closed book
3	Assignments	10	Bi-weekly	Take home
4	Class Tests*	25	During the weekly lecture hour	Pre-announced, Open note/book

*There will be three class tests on topics (1,2); (3,4) and (5,6). The best two performances will be included in the final grading. **There will be no make-up for the class tests.**

Make-up policy: Makeup will be given for the Mid-semester exam and comprehensive exam on grounds accepted by AUGSD.

Office Hours: Feel free to call the I.C. at ext: 873 or drop an email for an appointment on the same date.

Indrakshi Raychowdhury
Instructor-in-charge