PHY-683A Techniques in Experimental High Energy Physics

Semester I (2024-2025), **3-0-0-0(9)**

Instructor:	Navaneeth Poonthottathil		
Email:	navaneeth@iitk.ac.in	**Phone:**	512-679-2350

Lecture timing M 15:30-17:00, T 14:00-15:15
Location : T 209
Recommended Books: This is a restricted list of interesting and useful books to be touched on during the course.

- W.R. Leo; Techniques for Nuclear and Particle Physics Experiments (Springer Verlag).
- Glenn F. Knoll, Radiation Detection and Measurement (John Wiley & Sons)
- Statistics – R. J. Barlow (John Wiley & Sons)
- L. Lyons, A Practical Guide to Data Analysis for Physical Science Students. (Cambridge University Press)
- G.Cowan, Statistical Data Analysis(Oxford Science Publications)

References:

Donald H. Perkins, Introduction to High Energy Physics. (Cambridge University Press)

https://www.hep.phy.cam.ac.uk/~thomson/

https://root.cern

Objectives: The main objective of this course is to provide PG students with an understanding of the fundamental techniques used in advanced particle physics experiments, detector systems, as well as the statistical methods necessary to analyze the data obtained from these experiments.
Prerequisites: An undergraduate-level understanding of basic particle physics and quantum mechanics
Tentative Course Outline:

- Review of the special theory of relativity, choice of units, classifications of particles, the concept of fixed target and collider experiments, neutrino physics, neutrino Oscillations, two-flavor approximation, different types of neutrino interactions, concepts of neutrino oscillation measurement experiment.
- Interaction of radiation with matter(focuses on building detector technology), energy loss mechanism, Bethe-Bolch formula, energy loss mechanism for charged particles, photons, and neutrons, general ideas for designing various types of particle detectors, and working principles of the detectors, Cherenkov detectors, scintillators, gaseous and semiconductor detectors, Calorimeters, spectrometers, Time Projection Chambers, Position and time measurement in detectors, Liquid Argon Technology for high precision particle interaction measurements
- Statistics and Data Analysis Techniques: Basic ideas of probability, random variable, probability distribution, statistical test, significance and power, the goodness of fit, estimators - likelihood, χ^2 method, the idea of maximum likelihood, confidence interval, incorporation of systematic effects and statistical error in data analysis, propagation of errors, general philosophy of Frequentist and Bayesian interpretation, ROOT software, construction of root tree structure for storing and reading the data

Grading Policy: Assignments/Quiz(20), Midterm(30), Final(50)

Class Policy:

- Regular attendance is expected.
- DOAA Guidelines use of unfair means will be strictly followed.