Intensive Graduate Course

Course Title:	**Selected topics in physics I** (1 credit)
Course Code:	Fac. of Sci. M:R0211 D:R0212
	Fac. of Sci.& Eng. M:R211 D:R212
Subtitle:	**Neutrino oscillation physics at long-baseline experiments**
Lecturer:	Dr. Manojit Ghosh (Harish-Chandra Research Institute)
Date & Hours:	Oct. 31 (Wed) Periods 2, 4, 5
	Nov. 1 (Thu) Periods 2, 4, 5
	Nov. 2 (Fri) Periods 2, 5
Room:	8–307

Abstract:
I will give a series of lectures on neutrino oscillation physics at long-baseline experiments. The lectures will be given in English. Each lecture will include tutorials consisting of both numerical and analytical problem solving. As the lectures will be based on the ongoing developments of the current research, it will be great if the students bring their laptop computers. It will also be helpful for numerical problem solving. The contents of each lecture are given on the following page.

Registration should be made at the Academic Administration Division of the main office of Faculty of Science **by Oct. 24 (Wed)**.

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- Lecture 1:

(a) **Neutrinos and their properties**

(b) **Neutrino oscillation**

vacuum oscillations and matter effects

(c) **Derivation of Neutrino oscillation probability**

two flavor vacuum, two flavor matter, 3 flavor one mass scale dominance approximation, 3 flavor small θ_{13} approximation

(d) **Neutrino oscillation experiments/long-baseline experiments**

production and detection mechanisms, signal and backgrounds, charge current and neutral current events

(e) **Current status of neutrino oscillation parameters**

- Lecture 2:

(a) **Parameter degeneracy in neutrino oscillation experiments**

hierarchy-δ_{CP} degeneracy, octant-δ_{CP} degeneracy, generalized hierarchy-octant-δ_{CP} degeneracy

b) **Tutorials of lecture 1**

intermediate steps of derivations, plotting probability formulas and understanding oscillatory behaviors

- Lecture 3:

(a) **The method of χ^2 analysis for studying neutrino oscillation physics**

flux, cross section, energy resolution, efficiency, calculating events, marginalization, priors, systematic errors, Gaussian and Poisson distributions

(b) **Tutorials of lecture 2**

understanding degeneracy by numerical analysis

- Lecture 4:

(a) **Neutrino oscillation beyond standard three flavor scenario**

non standard interactions and sterile neutrinos

(b) **Tutorials of lecture 3**

estimating sensitivity of the experiments by χ^2 analysis

Reference: M. Ghosh, "Present Aspects and Future Prospects of Neutrino Mass and Oscillation," arXiv:1603.04514 [hep-ph].