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IPT 591300 Relativistic Photonics

國立清華大學光電工程研究所

Prof. 黃衍介 Class location: HOPE Lab 406
Summer 2010 Class schedule: M7M8M9

Teaching Assistants (TAs): 陳家祥

This course is meant to establish a background for graduate students who intend to conduct research on relativistic radiation and acceleration. We will start from classic and relativistic electrodynamics. Then we study energy coupling between relativistic electrons and radiation. Finally we introduce various radiation devices such as Cherenkov, Smith-Purcell, and undulator free-electron lasers.

A unique feature of this course is that each student is required to finish a design of an FEL by the end of the semester.

Course Content

- **Text Reading**
  1. Relativistic electrodynamics
  2. Radiation from a charged particle
  3. Relativistic Electron Beam
  4. Single particle theory of FEL
  5. Collective theory of FEL
- **Project Study**

1. Chiahsian: Cherenkov FEL
2. Kuanyan: Smith-Purcell FEL
3. Fuhan: Undulator FEL
4. Nuanya: Thomson FEL

Textbooks

Classical Relativistic Electrodynamics – Theory of Light Emission and Applications to Free-electron Lasers, by T. Shiozawa, Springer, 2004

Grading Policy:

Q&A from reading assignment: 20% (In the first hour of the class, each student is expected to ask and answer questions)
Weekly Presentation: 40% (In the 2nd and 3rd hour of the class, each student presents his/her project study for 20-25 min.)
Final report: 40%

Project study is very important for this course. Since all students taking this course are PhD students working on FEL, I would like to use this course to lay a ladder for your PhD thesis. The goal of your project study is set in the **stimulated emission regime**, producing laser-like radiation from your FEL. The design project covers a range from **injector/accelerator, transportation, and laser radiation**.

To be practical, please carry out the project with an experimental plan either at HOPE Lab or NSRRC. **Novelty, creativity, and experimental feasibility** are the key points in evaluating your performance.

For each project, I prefer to see a draft of **a theoretical paper** ready for submission by the end of this semester. Your final grade crucially depends on the success of paper submission **AND** your participation in other's projects.

The following is a tentative schedule for the lectures/presentations of the course. We could modify/improve some arrangement during the semester, but will keep the structure as is. **You are advised to prepare yourselves ahead of the schedule** so that you can trade yourselves some time to correct mistakes or make changes to your project. To make good progress, you are also advised to discuss your project from time to time (off the class) with me, Prof. Mishra, your thesis supervisors, and experts of the field.

March 14,
- Reading assignment: Sec 2.1-7
- Lecture by Prof. Huang: concepts of Cherenkov, Smith-Purcell, Undulator, and Thomson radiations

March 21,
- Reading assignment: Sec 2.8-3.2
- Project presentations: system layout

March 28,
- Reading assignment: Sec 3.3-3.7
- Lecture by Dr./Prof. Liang: light source requirement – from user's point of view
- Project presentations: system parameter breakdown

April 4,
- Reading assignment: Sec 3.8-4.3.1
- Project presentations: injector/accelerator

April 11,
- Reading assignment: Sec 4.3.2-4.7
- Project presentations: injector/accelerator

April 18,
- Reading assignment: Sec 4.8-4.10
- Project presentations: injector/accelerator

April 25,
- Reading assignment: Sec 4.8-4.10
- Project presentations: beam transportation

May 2,
- Reading assignment: Sec 5.1-5.4
- Project presentations: beam transportation

May 9,
- Reading assignment: Sec 5.5-5.7
- Project presentations: beam transportation

May 16,
- Reading assignment: Sec 5.5-5.7
- Project presentations: FEL theoretical modeling

May 23,
- Reading assignment: Sec 6.1-6.3
- Project presentations: FEL theoretical modeling

May 30,
- Reading assignment: Sec 6.4-7.4
- Project presentations: FEL – simulation modeling

June 6, Dragon boat festival
June 13,
- Reading assignment: Sec 7.5-8.3
- Project presentations: FEL – simulation modeling

June 20,
- Reading assignment: Sec 8.4-8.5
- Project presentations: Engineering layout for an experiment

June 27, final report/paper due