
Last update Feb. 8, 2013

IPT 591300 Relativistic Photonics – free-electron laser
(NTHU/NCTU/NSRRC Advanced Light Source Program Course)
Spring 2013

Class location: EECS106 (limited to 25 students), Class schedule: M5W3W4

Primary lecturer/course coordinator

Prof. Yen-Chieh Huang, Department of Electrical Engineering, NTHU

Guest Lecturers

Alex Chao, Professor, Stanford University/ SLAC National Accelerator Laboratory/Academician, Academia Sinica

Juhao Wu, Research scientist, SLAC National Accelerator Laboratory

Teaching Assistant: 趙美涵, s9801801@m98.nthu.edu.tw, x 62333

This course is meant to establish a background for graduate students who intend to understand or to conduct research on relativistic photonics. The 2nd half of the course will emphasize free-electron laser (FEL), the most pioneering fourth generation of light sources. The course content contains three parts, Classic FEL, SASE/HGHG FEL, and future FEL.

Classic FEL, taught by Prof. Yen-Chieh Huang in the first 10 weeks, introduces the basic knowledge on relativistic electrodynamics leading to various kinds of mature FEL technologies.

SASE/HGHG FEL, taught by academician Prof. Alex Chao in two weeks, introduces the theory of single-pass FEL and FEL amplifier.

Future FEL, taught by Dr. Juhao Wu of SLAC, describes new innovative schemes and physics for next generation FELs, including a review on worldwide FEL facilities and proposals.

Course Content

Classic FEL

Week 1, Feb. 18/20, relativistic electrodynamics

Week 2, Feb. 25/27, particle radiation

Week 3, March 4/6, electron beam

Week 4, March 11/13, beam-wave interactions

Week 5, March 18/20, Cherenkov/BWO/ Smith-Purcell FEL

Week 6, March 25/27, Cherenkov/BWO/Smith-Purcell FEL

Week 7, April 1 (April 3, Spring Break) Cherenkov/BWO/Smith-Purcell FEL

Week 8, April 8/10, Undulator FEL – single particle theory

Week 9, April 15/17, Undulator FEL – small signal gain

Week 10, April 22/24 Undulator FEL Oscillator

SASE/HGHG FEL

Week 11, April 29/May 1, SASE FEL

Week 12, May 6/May 8, HGHG FEL

Week 13, May 13 (IPAC week), mid-term exam

Future FEL

Week 14, May 20/22, SASE FEL (continue): Maxwell-Vlasov coupled equations;

Super-radiance FEL, ultrashort single spike FEL, iSASE, pSASE, multi-color FEL

Week 15, May 27/29, Seeded FEL (continue): EEHG/Modulation Compression Harmonic Generation(MCHG), HHG seeding, self-seeding

Week 16, June 3/5, Terawatts FEL via self-seeding or iSASE and tapering

Week 17, June 10 (June 12, dragon-boat festival), Undulator technology: APPLE/DELTA undulator with different polarization; Existing/proposed XFEL projects survey

Week 18, June 17, final exam

Reference books

1. Classical Relativistic Electrodynamics – Theory of Light Emission and Applications to Free-electron Lasers, by T. Shiozawa, Springer, 2004.
2. Ultraviolet and Soft X-Ray Free-Electron Lasers – Introduction to Physical Principles, Experimental Results, Technological Challenges, by P. Schmuser, M. Dohlus, J. Rossbach, Springer, 2009
3. Notes of some of the lectures will be distributed.

Grading Policy

Quiz, homework, midterm exam, and final exam account for 20%, 20%, 30%, and 30% of a student's final grade, respectively. The scope of the final exam contains everything taught in the semester.