FORMALITIES

Eric Prebys, FNAL
Goals of this course

• I hope this course will provide you with…
  • a rigorous foundation of the underlying physics of particle accelerators,
    • Fairly sophisticated understanding of their operations.
    • The background to pursue more advanced studies on your own (or in further classes).
  • a quantitative overview of the state of the art, as well as current and future challenges.
  • familiarity with enabling and related technologies:
    • Magnets
    • RF
    • Instrumentation
    • etc.
Course Personnel

• Instructor: Eric Prebys, FNAL
  • prebys@fnal.gov
  • 630-336-1893

• Lab Instructor: Elvin Harms, FNAL
  • harms@fnal.gov

• TA: Brian Beaudoin, University of Maryland
  • beaudoin@umd.edu

• Grader: Bryant Garcia, Stanford
  • bryantg@stanford.edu
Some warnings right up front

• This course is intended to cover in two very intense weeks the material that would be in a full semester university course
  • That’s the mandate; there’s nothing I can do about it
• Students have a pretty broad range of backgrounds, so some will struggle more than others.
• If you get behind, you will never catch up!
  • Ask questions
  • Attend help sessions
  • Work together
• This is my first time teaching the Fundamentals course*, and if I go off track, we all will never catch up
  • I appreciate feedback and constructive criticism

*taught the graduate course a few times
Class Demographics

Educational Level
- Undergraduate
- Bachelor's or in Grad School
- Master's
- PhD

Field of Study
- Physics/Math/Didn't specify
- Engineering
My Background

- **1984:** BS in Engineering Physics, University of Arizona
  - Got a job in an HEP group after being fired from a gas station.
- **1984-1990:** Grad Student, University of Rochester
  - PhD topic: Direct Photon Production in Hadronic Interactions
- **1990-1992:** CERN Fellow, CERN
  - Studied e+e- reactions on the OPAL Experiment at LEP
- **1992-2001:** RA and Assistant Professor, Princeton U.
  - GEM Experiment at the Superconducting Super Collider 😞
  - Belle CP Violation Experiment at KEK, Japan
  - Nonlinear QED in E-144 Experiment at SLAC
- **2001-Present:** Scientist, Fermilab
  - Past:
    - MiniBooNE short baseline neutrino oscillation experiment
    - Proton Source Department Head
    - Director of LHC Accelerator Research Program (LARP)
    - Director of Joint University-Laboratory PhD Program
  - Present:
    - Mu2e rare muon conversion experiment
    - Integrable Optics Test Accelerator (IOTA) proton injection
    - Program director for Lee Teng Undergraduate Internship
    - Occasional Instructor at USPAS
Fermilab E-706 Rochester Group
~1987

Me

“Buck’s River Road Exxon”
General Plan

• I’m going to spend today on the basics, as well as a fairly qualitative overview of everything we’re going to learn
  • This will hopefully level the playing field in terms of previous experience and exposure to the concepts
• I’m planning to give an in depth treatment of
  • Transverse motion
    • Strong focusing
    • Lattice functions
  • Longitudinal motion
    • Acceleration
    • Synchrotron motion
• More qualitative treatment of general topics in the field
  • Will mix up the two, to give your brains a rest.
A note on text

- I chose Edwards and Syphers “An Introduction to the Physics or High Energy Accelerators” as the primary course text because
  - It’s the book I learned from
  - I find the mathematical level appropriate to a broad range of students.
  - It was written by Fermilab people, so it uses conventions that I’m familiar with.
  - It’s the same book I use for the graduate course, but we’ll cover much less of it, and at a less rigorous level.
  - I won’t stick to the order of the book. In particular, like most people who use it, I’ll switch the order of Chapter 2 (longitudinal motion) and 3 (transverse motion)
Other references

- Edmund Wilson, “Particle Accelerators”
  - A bit lower level than E&S. Often used for this course.
  - Concise reference on a number of major topics
  - Available in paperback (important if you are paying)
- Klaus Wille “The Physics of Particle Accelerators”
  - Same comments
- Welmut Wiedemann, “Particle Accelerator Physics”
  - Probably the most complete and thorough book around (originally two volumes)
  - Scope very large and mathematical level very high, even for the graduate course.
- Fermilab “Accelerator Concepts” (“Rookie Book”)
  - http://tinyurl.com/FNAL-concepts
  - Particularly chapters II-IV
Tentative Schedule

• Lecture: 9-12
  • Will lecture in the afternoon a bit today.
• Lunch: 12-1:30
• Labs: 1:30-5:00
• Problem sessions: 7-??
• Homework every day except Friday and next Thursday, to be turned in the next day.
  • Students are encouraged to work together on homework
• In-class exam next Friday.
• As lectures, homework, and other material are ready, they will be put at:
  • http://home.fnal.gov/~prebys/misc/uspas_2016/
## Course Schedule (very approximate)

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Lecture Style

• All the details of my lectures will be in my PowerPoint slides, which I will copy and hand out (they’ll also be available online).
  • This is first time I’m teaching this course, so there will be mistakes in the slides, which I’ll correct in the online version if and when we catch them.

• I will often write on the board simply as a way to pace myself (otherwise, I find I go way too fast). Sometimes this will involve simply copying what’s on the slides.

• I’ll also work through a lot of problems and examples that aren’t in the slides, so that’s where you’ll want to take notes. I’ll copy and distribute any I think are particularly valuable, but don’t count on it.

• I used to think that if people didn’t ask questions, it’s because they understood everything I was saying. Now I know the opposite is true, so if I don’t get any questions, I’ll keep slowing down until I do.