COURSE INFORMATION

PHYS 673: *Beam Physics I*

Course **Blackboard Learn** *website available @* webcourses.niu.edu!

General Information

Location: LT 227 (conference room)
Time: Spring Semester of 2014, Mondays and Wednesdays, 12:30 – 1:45 pm
Instructor: Dr. Bela Erdelyi
E-mail: berdelyi@niu.edu
Phone: (815) 753-6484
Office hours: before classes, 11:00am - 12:00pm in LT 225

Duration: 15 weeks, i.e. 30 lectures
Exams: No midterm or final exams
Homework Assignments: 4 sets, with clearly defined due dates/times. Homework sets will be your take-home exams. Late turn in of homework permissible only under unusual circumstances.
Recitation: every student is required to participate in the 4 sessions for solving homework problems. Each student will solve at least one problem on the blackboard, showing all steps of the process and explaining them to fellow students.
Grading: 70% homework + 20% recitation + 10% attendance and participation
Letter Grades: an aggregate numerical value of at least 50% of the total points on the homework is required to pass the course. The cutoff for an A grade will be approximately 85%.
Course Expectations: read assigned material before lectures, attend the lectures, participate in discussions, read the appropriate sections of the lecture notes again after lectures, complete and turn in homework in a timely manner, and solve as many problems as you can. Expect to spend 6-9 hours per week outside classes on this course. You are encouraged to set up study groups, work together on problems, discuss them online, but the solutions turned in must be your own. Cite any material you used from publications, the web, etc. Homework turned in should be professional, clearly legible, showing all work, steps involved, derivations, etc. It is recommended to type up all homework solutions in Latex, Word, or Mathematica, etc.

Course Description

Beam physics can be categorized in different ways. In broad lines, PHYS 673 is an introductory graduate level course on linear single particle beam physics. Students will gain a deeper understanding of physics, the interrelations among the core subjects of physics and beams, develop a new skill set and intuition for beams and their applications, and will be able to apply

their knowledge to accelerator physics, accelerator-based sciences, industrial processes, beam-based medical therapies, etc.

Prerequisites: previous course(s) on electricity and magnetism at the level of D.J. Griffiths, Introduction to Electrodynamics, 3rd edition, Prentice-Hall (1999) and graduate level classical mechanics, as for example H. Goldstein, Classical Mechanics, 3rd edition, Addison-Wesley (2001). An undergraduate level course on geometric light optics would be useful, but not required.

Required textbook: there is no required textbook. Lecture Notes are available. However, it is recommended that in addition you take notes during class.

Optional Readings: for a deeper understanding, you may also want to consult some optional material. Examples are posted on the Blackboard website set up for the course.

Topics

Chapter 1: Introduction, Background and Review

1. *What is Beam Physics?*
2. *Review of relevant classical mechanics and electrodynamics topics*
3. *Production of beams*
4. *Historical overview of accelerators*
5. *Some current applications of accelerators (proton therapy and CT)*
6. *Crash course on matrix glass/light optics*

Chapter 2: Charged Particles in Electromagnetic Fields

1. *Fields and potentials*
2. *Equations of the motion*
3. *Transfer matrices: theory*
4. *Transfer matrices: examples of some common elements*

Chapter 3: Properties of Maps and Devices

1. *Generalizations of the transfer matrix concept to high order: the truncated Taylor transfer map*
2. *Description and application of map symmetries*
3. *Specific charged particle optics devices and their maps*

Chapter 4: Periodic Beam Transport

1. *The linear theory*
2. *Invariant and beam ellipses*
3. *Phase space action of elements*

Chapter 5: A Glimpse at Nonlinear Beam Dynamics

1. *Nonlinear effects and aberrations*
2. *Things not covered …*

Accessibility Statement

Northern Illinois University is committed to providing an accessible educational environment in collaboration with the Disability Resource Center (DRC). Any student requiring an academic accommodation due to a disability should let his or her faculty member know as soon as possible. Students who need academic accommodations based on the impact of a disability will be encouraged to contact the DRC if they have not done so already. The DRC is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 (V) or drc@niu.edu.