ADMINISTRATIVE ITEMS

Introduction to Particle Accelerators
8.277 and 6.608

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My goals for this course

- Get you interested in accelerator science & technology for graduate study
- Make you knowledgeable about how “machines” influence accelerator-based science
- Put fundamental concepts of the topic above complicated mathematics
- Be responsive to your interests and goals
- Have an interactive experience in which we learn from each other

Credit Requirements

- Students will be evaluated based on
  - 10 homework assignments (30 % of final grade)
    - Discussion of problems is okay
    - Final work product must be independent
  - In lieu of periodic exams (35 % of final grade)
    - "Research" assignment & oral presentation (April 28) (20 % of grade)
      - Topic related to accelerator-based science
        (10 min presentation, 5 slides) + 3 page write up
      - Projects separate, but collaboration is encouraged
      - Get topic approved by March 19
    - Cyclotron lectures & project (graded) with Dr. Timothy Antaya (March 31 & April 2) (15 % of grade)
  - Final exam (35% of final grade) – two hours
    - Date to be determine by next week

Calendar: Assignments & special topics

February 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
27	28	29	30		1	2
3	4	5	6 • Accel class	7	8	9
10	11 • Accel class	12	13 • Accel class Homework due	14	15	16
17	18 Holiday	19	20 • Accel class	21	22	23
24	25 • Accel class Homework due Special lecture	26	27 • Accel class	28	29	1

March 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
24	25 • Accel class Homework due	26	27 • Accel class	28	29	1
2	3 • Accel class Homework due	4	5 • Accel class	6	7	8
9	10 • Accel class Homework due	11	12 • Accel class	13	14	15
16	17 • Accel class Homework due	18	19 • Accel class Approve topics	20	21	22
23	24	25	26	27	28	29
30	31 • Accel class • antaya lecture	1	2 • Accel class • antaya lecture	3	4	5

April 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
30	31 • Accel class • Antaya lecture	1	2 • Accel class • Antaya lecture scheduled	3	4	5
6	7 • Accel class **Homework due**	8	9 • Accel class	10	11	12
13	14 • Accel class **Homework due**	15	16 • Accel class	17	18	19
20	21 Holiday	22	23 • Accel class • Visit Bates	24	25	26
27	28 • Accel class **Student talks**	29	30 • Accel class	1	2	3

May 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
27	28 • Accel class **Homework due**	29	30 • Accel class	1	2	3
4	5 • Accel class **Homework due**	6	7 • Accel class	8	9	10
11	12 • Accel class	13	14 • Accel class	15	16	17
18 • Exam week	19	20	21 **EXAM WEEK**	22	23	24
25	26	27	28	29	30	31

Outline of Instructional Units

- Unit 1 Motivation & Fundamentals
  - Special relativity & electromagnetism prerequisites
  - Properties of particle beams, phase space & emittance
  - Measuring beam properties
- Unit 2 Figures of merit from accelerator based science
  - Historical development of accelerator types
  - Synchronism and Phase Stability-1
- Unit 3 RF cavities – basic principles
  - Lumped circuit analogy
  - Characteristic metrics
- Unit 4 RF Pillbox cavity
  - Coupled rf-cavities
  - Standing wave structures
- Unit 5 Slow wave structures
  - Traveling wave linacs
  - Scaling relationships for linacs

Instructional Units - continued

- Unit 6 Energy gain & beam loading
  - Wakefields & instabilities
- Unit 7 Linear optics
  - Beam transport and focusing
  - Accelerator visit
- Unit 8 Modern synchrotrons and storage rings
  - Optical functions and betatron motion
  - Bending and focusing magnets
  - Characteristic ring parameters
- Unit 9 Longitudinal dynamics &phase space
  - Synchrotron and betatron motion
  - Tune space
- Unit 10 Practicum – Designing a cyclotron

Instructional Units - continued

- Unit 11 Synchrotron radiation
  - Emittance control and beam cooling
  - Beam control and timing
- Unit 12 Light sources & free electron lasers
- Unit 13 Special topics -I
  - Colliders
  - Accelerator visit -II
- Unit 14 Special topics - II
  - Beam sources
  - Radiation and shielding
  - Accelerators for radiation therapy (Feb. 25)

No required text, but I will suggest readings

- Please download the following classic report
  - Physics of Electron Storage Rings, M. Sands, SLAC-r-121

    www.slac.stanford.edu/pubs/slacreports/slac-r-121.html

    This a great piece of physics pedagogical writing. Not really a text but a monograph meant to educate. It is the best introduction that I know of the physics of storage rings
  - I also recommend reports & lecture write-ups on the next slide & available on the web,

- I have asked the physics reading room to order two text as references that you may find helpful. I will use some exercises from these books
  - Accelerator Physics: Volume I & II by H. Wiedemann, (Springer Student Edition, Advanced Texts in Physics), 2004
  - Introduction to the Physics of High Energy Accelerators, D.A. Edwards and M.J. Syphers, J. Wiley Series

Lectures write-ups on the web

- US Particle Accelerator School lectures http://uspas.fnal.gov/lect_note.html
  - Introduction to Microwave Linacs, D.H. Whittum, SLAC-PUB 8026
  - Lecture notes on Classical Mechanics and Electro-magnetism in Accelerator Physics, G. Stupakov
- CERN Accelerator School lectures http://cas.web.cern.ch
  - Beam Diagnostics for Accelerators, H. Kozial
  - Introduction to Radio-Frequency Linear Accelerators, J. LeDuff
  - Cyclotrons, T. Stammbach
  - Transverse Motion, E. J. N. Wilson
  - Transverse Beam Dynamics, E. J. N. Wilson
  - Synchrotron Radiation, R. Walker
  - Beam Cooling, D. Möhl
  - Induction Linacs, J. de Mascureau
- University of Berlin Technical Engineering Notes (1996)
  http://www-tet.ee.tu-berlin.de/tet_note.html
  - Introduction to High Energy Linear Accelerators, H. Henke
  - Introduction to Radio-Frequency Linear Accelerators, H. Henke

And a word from my sponsor

What can you do after this course?

S-2008 USPAS at the University of Maryland				
Guest Lecture: Frontiers of Accelerator Technology				
Two Weeks				
Accelerator Fundamentals	Y. Wu & S. Mikhailov (Duke), J. Wu (SLAC)			
Accelerator Physics	W. MacKay & T. Satogata (BNL)			
Beam Dynamics Experiments at UMD	R. Kishek (Univ. of Md.) & UMd Team		Experimental course	
RF Superconductivity	J. Delayen (JLAB)			
Beam Physics with Intense Space Charge	J. Barnard & S. Lund (LLNL)			
One Week				
Applications of Accelerators in Medicine (include treatment planning if possible)	J. Flanz (Mass Gen)		Radiation Detection & Imaging for Medicine & Security	T. Budinger (LBL)
Laser Plasma Accelerators	C. Schroeder & E. Esarey (LBL)		Applications of Lasers in Accelerators	Y. Li (ANL)
Vacuum Tube Engineering	Lecturer from Thales Components Corp		Microwave Sources	B. Carlsten and S. Russell (LANL)
Beam-Based Diagnostics	C. Steier & G. Portmann (LBNL) & J. Safranek, SLAC		Control Room Physics Application Programs	J. Galambos and C. Allen (ORNL)

Come to Maryland this June

USPAS opportunity

- Since 1987 USPAS is organized as a university course program (academic courses for credit)
- 2 schools annually hosted at different US universities
- Typical attendance per school ~ 130 students
  - → Scholarships available for matriculated, for-credit students
    - Covers tuition, room, breakfast & dinner, books