PHY 420: Introduction to Accelerator Science and Technology, Fall 2017

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Office hours (preferred method of contact): Tuesday 11-12 am
Class Meeting Times: Monday/Wednesday 4:00-5:20 PM

Course Description:
This course will introduce students to the field of accelerator science and technology, a very versatile branch of physics and technology. This course is composed of the following parts: introduction of accelerator history and their basic principles, basic beam dynamics in synchrotrons, introduction of challenges in Accelerator physics, and introduction of typical beam measurements and instrumentations

Prerequisite*:* PHY 277, PHY 300, PHY 301, PHY 302, and PHY 303
Pre- or corequisite: PHY 335

Learning objectives:
Upon completing this course, students will be able to

- Define the basic terminology and analyze the principles of particle acceleration
- Solve problems of linear beam dynamics in longitudinal and transverse dimensions
- Identify the sources of nonlinear beam dynamics, interpret the consequences, and explain the strategies for mitigation of their effects
- Describe the instabilities that result from collective particle dynamics and describe the consequence of these effects for a particle accelerator
- Explain the operation principles of primary beam instrumentation and measurement devices

Course requirement:
Required Text:
An Introduction of Accelerator Physics for High Energy, Edwards & Syphers
Recommended Text:
An Introduction to Particle Accelerators, E. J. N. Wilson (A good complement to Edwards and Syphers)
An Introduction to Physics of Particle Accelerators, Conte and MacKay (a more advanced treatment)
Particle Accelerator Physics, Wiedemann, vol. 1 (Grad level and comprehensive)

Topics:
We will generally follow the Edwards & Syphers, but the course will include a few special topics:

1. Particle motion in electromagnetic field - Maxwell eqn/relativity review (1 week)
2. A brief history of accelerators
3. Longitudinal motion in accelerators

4. Transverse motion in accelerators
5. Transverse nonlinear and coupled motion
6. Beam instabilities
7. Emittance preservation
8. Synchrotron radiation
9. (Special Topic): Beam measurement and diagnostics
10. (Special Topic): Introduction to plasma wakefield acceleration

Approximate timeline: the first four topics are foundational and are expected to take six weeks. We will spend roughly five weeks on topics 5-8, which cover the finer points of accelerators, and only the major features will be covered at a high level. Topics 9 and 10 will be covered in two weeks (one week each) and one week will be allocated to class presentations (see below).

Grade Breakdown:

Homework: 15%

Homework will contain problem sets that will be posted on Wednesdays and will be due in a week.

Midterm: 25%

Midterm will be **on October 25th in class**.

Final: 40 %

Final exam will be cumulative, and included all topics covered in class

Presentations: 20%

The goal is to help you practice with presenting a scholarly work

- You must select a topic by the end of the second week on a paper of your choice relating to an experiment that has been performed at BNL recently
- You will give a 15 minute presentation with 5 minutes of questions.

Rules Regarding Homework:

- You may collaborate with your classmates on the homework's if you are contributing to the solution. You must **personally write up the solution of all problems**. It would be appropriate and honorable to acknowledge your collaborators by mentioning their names. These acknowledgments will not affect your grades.
- Do not forget that simply copying somebody's solutions does not help you and in a long run we will identify it. If we find two or more identical homeworks, they all will get reduced grades. You may ask more advanced students, other faculty, friends, etc. for help or clues, as long as you personally contribute to the solution.
- You may (and are encouraged to) use the library and all available resources to help solve the problems. Use of Mathematica, other software tools and spreadsheets are encouraged. Cite your source, if you found the solution somewhere.
- You should return homework **before the deadline**. Homework returned after the deadline could be accepted with reduced grading - 15% per day. Otherwise, it will be unfair for your classmates who are doing their job on time. Therefore, you should be on time to keep your grade high

University Policies

Disability Support Services (DSS) Statement:

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room 128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

[*In addition, this statement on emergency evacuation is often included, but not required:* Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities]

Academic Integrity Statement:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management Statement:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.