

Important Note: Every effort will be made to avoid changing the course schedule, but the possibility exists that unforeseen events will make syllabus changes necessary. It is your responsibility to check Blackboard for corrections or updates to the syllabus. Any changes will be clearly noted in course announcements or through Stony Brook email.

Part 1: Course Information

Course title: Introduction to Accelerator Science and Technology

Course catalog # and section: PHY 420.01

Credit hours: 3 credits

Semester: Fall of 2020

Prerequisites: PHY 277, PHY 300, PHY 301, PHY 302, and PHY 303

Pre- or corequisite: PHY 335

Instructor name: Navid Vafaei-Najafabadi

Instructor's Stony Brook email, phone number, and time zone:

navid.vafaei-najafabadi@stonybrook.edu (For private communication,
Reply in 24-48 hours)

631-632-0723 (For urgent communication, voicemail checked within
two hours)

New York Time Zone (EDT before Nov. 1 and EST Afterwards)

Office hours (preferred method of contact): Two time slots will be determined in the first week of classes based on the feedback from the students via an online poll. The office hours will be held via Zoom (my office is too small for effective social distancing).

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 instrumentation.



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Required Course Textbook and Materials:

An Introduction of Accelerator Physics for High Energy, Edwards & Syphers

Recommended Readings/Bibliography:

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)

Course Delivery Mode and Structure:

This is an *in-person* course. The class meets **Mondays and Wednesdays from 4:25PM - 5:45PM in Staller Center, room M0113***. The class will be broadcasted via Zoom simultaneously. The students will have access to the class recording through the Blackboard website. All assignments and course interactions will utilize internet technologies. See "Technical Requirements" section for more information. In Blackboard, you will access online lessons, course materials, and resources. Some variations will occur.

***Note:** Classes after Nov. 20 will no longer be in person and will be taught exclusively via Zoom

How We Will Communicate:

Office hours are the primary time intended for us to discuss course-related issues. If you cannot make the office hours, e-mail me for a separate appointment. For personal/private issues, email me directly. If you use Blackboard's **email tool** from the course site, it will automatically include your full name, course name and section when you send me an email. **Please allow between 24-48 hours for an email reply.** Your Stony Brook University email must be used for all University-related communications. You must have an active Stony Brook University email account and access to the Internet. All instructor correspondence will be sent to your SBU email account. **Plan on checking your SBU email account regularly for course-related messages.** To log in to Stony Brook Google Mail, go to <http://www.stonybrook.edu/mycloud> and sign in with your NetID and password.

Regular announcements will be sent from Blackboard. These will be posted in the course site and may or may not be sent by email.

Regular communication is essential in online classes. Logging in once a day, checking the discussion board and participating with your peers ensures that you are able to remain an active member of the class and earn full points for participation.

Technical Requirements:

This course uses Blackboard for the facilitation of communications between faculty and students, submission of assignments, and posting of grades and feedback. The Blackboard course site can be accessed at <https://blackboard.stonybrook.edu>

If you are unsure of your NetID, visit <https://it.stonybrook.edu/help/kb/finding-your-netid-and-password> for more information. You are responsible for having a reliable computer and Internet connection throughout the term. **Caution!** You will be at a disadvantage if you attempt to complete all coursework on a smart phone or tablet. It may not be possible to submit the files required for your homework assignments.

Students should be able to use email, a word processor, spreadsheet program, and presentation software to complete this course successfully.

The following list details a minimum recommended computer set-up and the software packages you will need to have access to, and be able to use:

- PC with Windows 10 or higher (we recommend a 3-year Warranty)
- Macintosh with OS 10.11 or higher (we recommend a 3-year Warranty)
- Intel Core i5 or higher
- 250 GB Hard Drive
- 8 GB RAM
- Latest version of Chrome or Firefox; Mac users may use Chrome or Firefox. (A complete list of supported browsers and operating systems can be found on the My Institution page when you log in to Blackboard.)
- High speed internet connection
- Word processing software (Microsoft Word, Google Docs, etc.)
- Headphones/earbuds and a microphone
- Webcam (recommended)
- Printer (optional)
- Ability to download and install free software applications and plug-ins (note: you must have administrator access to install applications and plug-ins).

Technical Assistance:

If you need technical assistance at any time during the course or to report a problem with Blackboard you can:

- Phone: 631-632-9800 (client support, Wi-Fi, software and hardware)
- Submit a help request ticket: <https://it.stonybrook.edu/services/itsm>
- If you are on campus, visit the Walk-Up Tech Support Station in the Educational Communications Center (ECC) building.

Part 2: Course Learning Objectives and Assessments

Upon completion of the 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

How to Succeed in this Course:

- Complete all assigned work in the course
- Speak up in class if you have difficulty following the lecture
- Attend office hours with questions and topics of discussion
- Use the available academic resources (see Part 6 of this syllabus)

Part 3: Course Schedule

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
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 three weeks (1.5 week each)

All classes before **November 20th** will be taught in person (with Zoom Broadcast recorded). Classes after November 20th will be taught exclusively via Zoom.

Part 4: Grading, Attendance, and Late Work Policies**Assessment and Grading:**

Homework: 15%

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

Midterm: 25%

Midterm will be **on Monday, October 12th**. The midterm will be posted on blackboard. Students can start the assignment any time during the day of October 12th, i.e. from 12:00 am to ~10 pm EDT (including in class time), but they can do so only once. Once the exam is started, students will have approximately two hours (exact time to be specified on the exam) to finish the exam. The midterm will be open book.

Final: 40 %

Final exam will be cumulative, and included all topics covered in class. The final will be of the same format as the midterm. The final is scheduled for **Wednesday December 9, 8:30-11:00PM**. The students can start the assignment any time during the day of December 9, i.e. from 12:00 am, but the no later than 8:30 pm Eastern Time. All exams are due at 11:00 PM Eastern time. The final will be open book.

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 using a particle accelerator (e.g. at BNL, CERN, SLAC, etc)
- You will give a 15 minute presentation with 5 minutes of questions.
- This presentation will take place at the last week of the class at a time agreed upon by students via poll

Viewing Grades on Blackboard: Points and feedback for graded activities will be posted to the My Grades tab in the Tools area of Blackboard. Assignments will be graded within the week.

Letter Grades:

Final grades assigned for this course will be based on the percentage of total points earned and are assigned as follows:

Grade	%
A (Superior Work)	85+
A-	72-85
B+	62-72
B (Good Work)	55-62
B-	50-55
C+	45-50
C (Satisfactory)	40-45

C-	35-40
F	<35

- Additional information
 - [Undergraduate Grading System](#)
 - [Graduate Grading System](#)

Attendance Policy: Attendance is strongly encouraged. In the event that students are not able to attend the class in person, links to Zoom recording will be provided so that the students may stay current with material taught in class.

Rules Regarding Homework:

- You may collaborate with your classmates on the homework if you are contributing to the solution. You must personally write up the solution of all problems.
- Do not forget that simply copying somebody's solutions does not help you in a long run (especially on the exam).
- 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.
- Late homework: Homework is accepted until the end of the following Wednesday class, but will incur a 20% penalty/(business) day late.

Part 5: University and Course Policies

University Policies:

Student Accessibility Support Center Statement:

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center. For procedures and information go to the following website: <https://ehs.stonybrook.edu/programs/fire-safety/emergency-evacuation/evacuation-guide-people-physical-disabilities> and search Fire Safety and Evacuation and 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 is 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

Important Note: Any form of academic dishonesty, including cheating and plagiarism, will be reported to the Academic Judiciary.

Critical Incident Management:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards 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. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.

Course Policies:**Understand When You May Drop This Course:**

It is the student's responsibility to understand when they need to consider withdrawing from a course. Refer to the Stony Brook Academic Schedule for dates and deadlines for registration: http://www.stonybrook.edu/commcms/registrar/calendars/academic_calendars.

- [Undergraduate Course Load and Course Withdrawal Policy](#)
- [Graduate Course Changes Policy](#)

Incomplete Policy:

Under emergency/special circumstances, students may petition for an incomplete grade. Circumstances must be documented and significant enough to merit an incomplete. If you need to request an incomplete for this course, contact me for approval as far in advance as possible.

Course Materials and Copyright Statement:

Course material accessed from Blackboard, SB Connect, SB Capture or a Stony Brook Course website is for the exclusive use of students who are currently enrolled in the course. Content from these systems cannot be reused or distributed without written permission of the instructor and/or the copyright holder. Duplication of materials protected by copyright, without permission of the copyright holder is a violation of the Federal copyright law, as well as a violation of Stony Brook's Academic Integrity.

Online Communication Guidelines and Learning Resources:

Maintain professional conduct both in the classroom and online. The classroom is a professional environment where academic debate and learning take place. I will make every effort to make this environment safe for you to share your opinions, ideas, and beliefs. In return, you are expected to respect the opinions, ideas, and beliefs of other students—both in the face-to-face classroom and online communication. Students have the right and privilege to learn in the class, free from harassment and disruption. The course follows the standards set in the Student Code of Conduct, and students are subject to disciplinary action for violation of that code. If your behavior does not follow the course etiquette standards stated below, the grade you receive for a posting may suffer. I reserve the right to remove any discussion messages that display inappropriate language or content.

Online Etiquette:

- Offensive language or rudeness will not be tolerated. Discuss ideas, not the person.
- Avoid cluttering your messages with excessive emphasis (stars, arrows, exclamations).
- If you are responding to a message, include the relevant part of the original message in your reply, or refer to the original post to avoid confusion;
- Be specific and clear, especially when asking questions.
- Use standard punctuation and capitalization. Using all UPPERCASE characters gives the appearance of shouting and makes the message less legible;
- Remember that not all readers have English as their native language, so make allowances for possible misunderstandings and unintended discourtesies.

Online Classes Require Better Communication:

It is important to remember that we will not have the non-verbal cues that occur in a face-to-face classroom. I cannot see the confused, frustrated, or unhappy expressions on your face if you encounter problems. You **MUST** communicate with me so that I can help. To make the experience go smoothly, remember that you're responsible for initiating more contact, and being direct, persistent, and vocal when you don't understand something.

My Role as the Instructor:

As the instructor, I will serve as a "guide" in our online classroom. While I will not respond to every post, I will read what is posted, and reply when necessary. Expect instructor posts in the following situations:

- To assist each of you when it comes to making connections between discussion, lectures, and textbook material.
- To fill in important things that may have been missed.
- To re-direct discussion when it gets "out of hand."
- To point out key points or to identify valuable posts.

Part 6: Student Resources

Academic and Major Advising (*undergraduate only*): Have questions about choosing the right course? Contact an advisor today. Phone and emails vary-please see website for additional contact information; website: <https://www.stonybrook.edu/for-students/academic-advising/>

Academic Success and Tutoring Center (*undergraduate only*):
<https://www.stonybrook.edu/tutoring/>

Amazon @ Stony Brook: Order your books before classes begin. Phone: 631-632-9828; email: Bookstore_Liaison@stonybrook.edu; website: <http://www.stonybrook.edu/bookstore/>

Bursar: For help with billing and payment. Phone: 631-632-9316; email: bursar@stonybrook.edu; website: <http://www.stonybrook.edu/bursar/>

Career Center: The Career Center's mission is to support the academic mission of Stony Brook University by educating students about the career decision-making process, helping them plan and attain their career goals, and assisting with their smooth transition to the workplace or further education. Phone: 631-632-6810; email: sbucareercenter@stonybrook.edu; website: <http://www.stonybrook.edu/career-center/>

Counseling and Psychological Services: CAPS staff are available by phone, day or night.
<http://studentaffairs.stonybrook.edu/caps/>

Ombuds Office: The Stony Brook University Ombuds Office provides an alternative channel for confidential, impartial, independent and informal dispute resolution services for the entire University community. We provide a safe place to voice your concerns and explore options for productive conflict management and resolution. The Ombuds Office is a source of confidential advice and information about University policies and procedures and helps individuals and groups address university-related conflicts and concerns. <http://www.stonybrook.edu/ombuds/>

Registrar: Having a registration issue? Let them know. Phone: 631-632-6175; email: registrar_office@stonybrook.edu; <http://www.stonybrook.edu/registrar/>

SBU Libraries: access to and help in using databases, ebooks, and other sources for your research.

- Research Guides and Tutorials: <http://guides.library.stonybrook.edu/>
- Getting Help: <https://library.stonybrook.edu/research/ask-a-librarian/>

Student Accessibility Support Center: Students in need of special accommodations should contact SASC. Phone: 631-632-6748; email: sasc@stonybrook.edu;
<https://www.stonybrook.edu/sasc/>

Support for Online Learning: <https://www.stonybrook.edu/online/>

Writing Center: Students are able to schedule face-to-face and online appointments.
<https://www.stonybrook.edu/writingcenter/>