Stony Brook University

Department of Physics & Astronomy
Online Syllabus

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: Theoretical Particle Physics

Course catalog # and section: PHY612

Semester: Fall 2020

Prerequisites: Quantum Field Theory I

Instructor name: Professor Rouven Essig

Instructor's Stony Brook email: rouven.essig@stonybrook.edu

Office hours: By appointment (contact via email).

TA Information: TBD

Course Description:

The Standard Model is an amazingly successful theory of the fundamental building blocks of matter and their interactions. This course will provide an introduction to the Standard Model of particle physics and some new physics not described by it. Prior knowledge of particle physics is useful, but not required. Some knowledge of quantum field theory is assumed (PHY 610 or equivalent). A tentative and incomplete list of possible topics is:

- Overview of the Standard Model of Particle Physics
- Symmetries: basics, Lie groups, Lie algebras, global symmetries, chiral symmetries, gauge symmetries (abelian and non-abelian)
- Spontaneous symmetry breaking
- Gauge theories: Abelian, non-abelian
- Quantum Electrodynamics (QED)

- The standard electroweak theory: discrete symmetries (P, C, CP) and their violation, the standard SU(2)xU(1) model, Higgs mechanism, tests, flavor physics
- Collider physics
- Neutrino masses and mixing, oscillations, MSW effect.
- Strong interactions and quantum chromodynamics (QCD)
- Chiral symmetry breaking in QCD
- Parton distribution functions
- Beyond the Standard Model: motivation, supersymmetry, grand unification, dark matter (all very brief)
- What's next in particle physics? (brief)

Required Course Textbook and Materials:

- M.D. Schwartz, "Quantum Field Theory and the Standard Model" (Cambridge, 2013)

Recommended Readings/Bibliography:

- P. Langacker, "The Standard Model and Beyond" (CRC Press)
- C. Quigg, "Gauge Theories of the Strong, Weak, & Electromagnetic Interactions" (Princeton, 2013)
- Additional material (including papers & review articles) may be suggested during the course.

Course Delivery Mode and Structure:
This is an online course delivered synchronously via Zoom. Students must be mindful of all course expectations, deliverables and due dates, especially because the online portion of the course requires significant time management. 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.

How We Will Communicate:
Course-related questions should be posted in the General Questions Forum in the course Discussion board. 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:
1. Describe the particle content of the Standard Model of Particle Physics and the interactions among the known particles.
2. Describe how fundamental symmetries determine the interactions among particles.

3. Calculate cross sections and decay rates for particle interactions.

4. Describe how observations and experimental data confirm the Standard Model, and how to go from the theoretical description of the Standard Model to experimental predictions.

How to Succeed in this Course:

- Attend all lectures.
- Complete all assigned readings in the course.
- Correctly complete all assigned homework on time.
- Perform well on the midterm and final exams.

Part 3: Course Schedule

The class will meet online on Tuesdays and Thursdays at 9:45am to 11:05am.

Part 4: Grading, Attendance, and Late Work Policies

Assessment and Grading:

There will be approximately 6 homework assignments that need to be completed over the semester (subject to change).

The course grade will be based on homework (35%), a midterm exam (25%), and a final exam (40%).

The midterm exam will be given synchronously during one of the official lecture periods (date TBD). The final exam will be online using the proctoring platform recommended by SBU, which will be announced at a later time.

Viewing Grades on Blackboard: Points and feedback for graded activities will be posted to the My Grades tab in the Tools area of Blackboard. The homework assignments and midterm exam will typically be graded within two weeks of submission.

Letter Grades:

Final grades assigned for this course will be based on the percentage of total points earned and are determined after evaluating the performance of the class overall, which depends on the difficulty of the assigned homework, midterm exam, and final exam.

Attendance Policy: You are strongly encouraged to attend all lectures.

Late Work Policy: I will not accept late work. However, you are free to discuss minor changes in the due date of an assignment with me well ahead of the due date. The new due date will then apply to all students.

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

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/