



Department of Physics and Astronomy
PHY 408 Syllabus
Spring 2021

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 on Blackboard and through Stony Brook email.

Part 1: Course Information

Course title: Modern Relativity

Course catalog # and section: PHY 408 section 1

Credit hours: 3

Semester: Spring 2021

General education designation(s) (SBC) : None

Prerequisite: PHY 302, PHY 303

Instructor name: F. Douglas Swesty

Contact: douglas.swesty@stonybrook.edu, Phone: 631-632-8055, Office: 463 Earth & Space Sciences Building. (Note: There will be no in-person meetings during the Spring 2021 semester)

Office hours: MW 2:30-4:00PM by Zoom meeting or by appointment via Zoom meeting.

TA Information: This course does not have a TA

Course Description:

A development of the special theory of relativity leading to general relativity with applications to cosmology.

Required Course Textbook and Materials: *A First Course in General Relativity* by Bernard Schutz, Second Edition, ISBN-13: 978-0521887052

Course Delivery Mode and Structure:

This is an *online course, delivered via Zoom meetings. There will be no in-person meetings for this course during the Spring 2021 semester.* Course lectures will be recorded and links to

those lectures will be placed on the course Blackboard site. **However, you are expected to be present for the lecture** in order to participate in the interactive nature of this class.

Students must be mindful of all course expectations and due dates, especially because this online course requires significant time management. All assignments and course interactions will utilize internet technologies. See “Technical Requirements” section for more information. Course lectures will be carried out synchronously during the scheduled class time. In Blackboard, you will access course materials, including recorded lectures, assignments, and additional resources. Each week of the semester has homework assignments; with deadlines usually on Fridays. Some variations in assignment due dates will occur but will be announced via Blackboard and email to your SBU email address.

How We Will Communicate:

Course-related questions should be asked during lectures and office hours. For personal/private issues, email me directly to set up a Zoom meeting. 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. I will try to answer promptly but **please allow for up to 24 hours for an email reply except for weekends when the reply will usually be sent on Monday.** 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 email correspondence will be sent to your SBU email account. I will not respond to emails from private email accounts. **Plan on checking your SBU email account daily 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.

Technical Requirements:

This course uses Blackboard and Zoom 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> Zoom may be accessed at stonybrook.zoom.us Both Blackboard and Zoom require authentication using your NetID. If you are unsure of your NetID, visit <https://it.stonybrook.edu/help/kb/finding-your-netid-and-password> for more information. Links to the lecture and office hour Zoom meetings will be posted on Blackboard.

This course will require you to **have access to a computer having an PDF file viewer and access to scanner and/or a cell phone with a scanning app so that you may submit your homework assignments and exams as PDF files.** It is recommended that the computer you use to attend the Lecture and Office Hour Zoom meetings have a webcam and microphone to facilitate interaction with the Instructor and other students in the class.

Students should be able to use email and navigate the SBU Blackboard website to complete this course successfully.

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.

If you need technical assistance with your personal computer you can:

- 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. Understand the theory of Special Relativity (SR)
2. Understand the theory of General Relativity (GR) including the Einstein Field Equations.
3. Understand the basics of vector and tensor analysis in 4-dimensional space-time.
4. Understand how to quantify the curvature of space-time.
5. Derive solutions to the Einstein Field Equations for several astrophysically relevant cases.

How to Succeed in this Course:

- *During each lecture you should take notes as the instructor presents the material. This process is important to the learning process. If you miss information as it is presented you should go back and watch the recorded lectures to fill in the gaps in your notes. If you still have questions about the material you should see the instructor during office hours or make an appointment to see the instructor. You must attend the lectures! If you do not keep up with the lecture material YOU ARE LIKELY TO FAIL THIS COURSE. You cannot succeed in this course by "cramming" the material all at once no matter how good your memorization technique is.*
- You should plan on spending two hours working through the lecture notes for each hour spent in lecture. In addition you will have to devote substantial amounts of time (usually at minimum of several hours per week) to complete the assignments.
- Ask for help from the Instructor. I will have office hours throughout the week, or meet with you by appointment, where you can ask for help. I am happy to provide that help. **Please take advantage of this opportunity to enhance your likelihood of success in this course.**
- For more time on task information, see NY State Education Department: <http://www.nysed.gov/college-university-evaluation/distance-education-program-policies>

Part 3: Course Schedule

[All lectures and Office Hours will take place completely online via Zoom meetings]

* Note that the dates in this schedule may be subject to change if the University schedule or University calendar changes

Date	Topic (subject to change)
Lect 1	Special Relativity (Schutz secs. 1.1-1.4)
Lect 2	Special Relativity (Schutz secs. 1.5-1.10)
Lect 3	Vector Analysis (Schutz secs. 2.1-2.5)
Lect 4	Vector Analysis (Schutz secs. 2.5-2.7)
Lect 5	Tensor Analysis (Schutz secs. 3.1-3.4)
Lect 6	Tensor Analysis (Schutz secs. 3.5-3.8)
Lect 7	Fluids in Special Relativity (Schutz 4.1-4.4)
Lect 8	Fluids in Special Relativity (Schutz 4.5-4.8).
Lect 9	Calculus in curved coordinate systems (Schutz 5.1-5.5).
Lect 10	Manifolds and curvature (Schutz 6.1-6.3)
Lect. 11	Quantifying curvature (Schutz sec. 6.4)
Lect 12	Quantifying curvature (Schutz sec. 6.5)
Lect. 13	Quantifying curvature (Schutz sec. 6.6) Take-home midterm exam posted at 6:00PM 3/15/21 *
Lect. 14	Quantifying curvature (Schutz secs. 6.6-6.7) Midterm exam due at 4:30PM 3/18/21 *
Lect. 15	Physics in curved spacetime (Schutz secs. 7.1-7.2)
Lect. 16	Physics in curved spacetime (Schutz secs. 7.3-7.4)
Lect. 17	The Einstein Field Equations (Schutz secs. 8.1-8.2)
Lect 18	The Einstein Field Equations (Schutz secs. 8.3-8.4)
Lect. 19	Gravitational radiation (Schutz secs. 9.1, 9.3-9.4)

Lect. 20	Spherical solutions of field equations for stars (Schutz 10.1-10.2)
Lect. 21	Spherical solutions of field equations for stars (Schutz secs. 10.3-10.5)
Lect. 22	The Schwarzschild solution and black holes (Schutz sec. 11.1)
Lect. 23	The Schwarzschild solution and black holes (Schutz sec. 11.2)
Lect. 24	The Schwarzschild solution and black holes (Schutz sec. 11.3)
Lect. 25	The Schwarzschild solution and black holes (Schutz sec. 11.3)
Lect. 26	Cosmology and the FRW solution (Schutz sec. 12.1)
Lect. 27	Cosmology and the FRW solution (Schutz sec. 12.2)
Lect. 28	Cosmology and the FRW solution (Schutz sec. 12.3) Take-home final exam posted.
Final Exam	Take-home final exam due at end of scheduled final exam period (consult the Registrars schedule). <u>Late exams will not be accepted.</u>

Part 4: Grading, Attendance, and Late Work Policies

Assessments and Grading: Course grades will be based on:

1. Homework assignments.
2. A take-home midterm exam.
3. A take-home final exam.

Homework Assignments: The policies for homework assignments will be posted in a separate document on Blackboard.

Midterm exam: The take-home midterm exam will be posted on Blackboard immediately after the completion of Lecture 13 and will be due at the beginning of class for Lecture 14. **Note that late exams will not be accepted for grading and will receive a zero score.**

Final exam: The take-home final exam will be posted immediately after the end of class for Lecture 28. The exam will be due at the end of the final exam period. **Note that late exams will not be accepted and will receive a zero score.** The scheduling of the final exam is controlled by the registrar and it is your responsibility to avoid final exam conflicts. To find out when the final exam for your section will take place please consult the registrars final exam schedule at https://www.stonybrook.edu/commcms/registrar/registration/_exams/fall20-finals.php

Course score: The course score will be weighted as follows: (1/3) for the homework assignments, (1/3) for the midterm exam and (1/3) for the final exam. Scores will be normalized to 100 (100 will be a perfect score for the course).

Viewing scores on Blackboard: Points and feedback for graded activities will be posted to the My Grades tab in the Tools area of Blackboard. Grades and graded exams assignments will typically be posted within one week, however in rare instances there may be exceptions to this timing.

Letter Grades: Final grades assigned for this course will be based on the percentage of total points earned an assigned based on the cutoffs listed below (Note that these cutoffs may be adjusted downwards at the Instructors discretion to set lower thresholds for grades). Total course percentages are computed to two decimal places. Letter grades will be assigned based on the following cutoffs (Note: The instructor reserves the right to adjust these cutoffs downward).

Letter Grade	Points or Percentage cutoffs
A	90
A-	80
B+	75
B	70
B-	65
C+	60
C	55
C-	50
F	<50

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

Attendance Policy: You are expected to attend all lectures. **It is unlikely that you will pass this course if you do not attend the lectures.**

Late Work Policy (including exams): Late work is not accepted except for reasons of absence due to military service, jury duty, mandatory court appearances, physical/mental illness, or death of a family member. **All proof of such absences should be submitted to the Office of the Dean of Students (Student Activities Center, Suite 222, phone: 631-632-7320).** Only after such proof has been verified by the Office of the Dean of Students will new deadlines be set for

the submission of missed assignments. Explanations of lost password, internet outage, power outage, computer malfunction, etc. **WILL NEVER BE ACCEPTED** as an excuse for failure to submit your work for an assignment by the specified deadline. **For this reason you should complete all assignments at least 24 hours prior to the deadline**, therefore proper planning is necessary on your part to make sure that you can complete your work in advance of the deadline for submission.

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:

Course Assignments & Academic Integrity Violation Policy:

Your grade in this course is, in part, based on software you will author in response to assignments that are given for this course. The key word here is “author”. Like authorship of any other document, authorship of software provides the possibility of plagiarism. Any attempt to submit work that draws from software authored by someone other than yourself is plagiarism and is an instance of an academic integrity violation. Any attempt to aid other students in authoring their software is also an instance of an academic integrity violation. You may not copy code from any source including, but not limited to, books, web sites, or other persons. By the use of the term “copy” we include electronic copies obtained by copying a computer file as well as reproducing code from other sources by typing it in, scanning it, optical character recognition, or any other means of reproducing that code. Your code must be authored solely by you. Altering variable names, spacing, reformatting, rearranging statements, changing file names, etc. of code from some other source does not result in original work and submitting such work as your own is an academic integrity violation. Debugging your code must be your own work and should be done solely by yourself with the following exception: you may request help in debugging from the Instructor and the Teaching Assistants for this course (hereafter TAs) but you may not obtain help from any other person. Any instance of obtaining help from anyone other than the Instructor and the course TAs to author or debug software that you submit for assignments will be considered an academic integrity violation. Students in this course may not discuss the software that they or another person are submitting in response to the course assignments with anyone other than the Instructor or the course TAs. Discussion of the software submitted in response to the assignments with anyone other than the Instructor or course TAs will be considered academic integrity violation.

The Stony Brook University Provost’s Academic Integrity Policy of August 2019 states “ *Course Instructors who suspect violations of academic integrity must report their suspicions to the Academic Judiciary Office; they may not establish a penalty independently.*” The course Instructor has no discretion in this matter. Accordingly any instance in which we suspect (we do not require definitive proof) that an academic integrity violation has occurred will, without exception, be reported to the Academic Judiciary Office. Once a report has been filed the Academic Judiciary Office (academic_judiciary@stonybrook.edu) has established formal procedures to handle the matter once suspected violations have been reported.

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.

Online Etiquette:

- When in Zoom meetings please keep your microphone muted until you are ready to speak.
- Offensive language or rudeness will not be tolerated. Discuss ideas, not the person.
- 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.
- 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:

The use of a webcam and microphone to participate during lectures is strongly encouraged. This helps to build a sense of community in the classroom. It is important to remember that we will not be as able to easily see 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. I will present a lecture explaining the course material. I will answer any questions you may have related to the course material. In addition will suggest reading for you and videos for you to watch which will enhance your learning experience. I, and the course TAs, will be available during office hours and by appointment to answer any questions that you have and assist you in the completion of your programming assignments. Office hours and contact information of myself and the TAs will be posted on the course Blackboard site.

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/>