PHY 408: Relativity (3 credits)

Time & Location: MWF (4:00-5:20) P116 Physics

Instructor: Prof. F. Douglas Swesty
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Office Hours: TBD

Purpose:

This course is designed to introduce you to Einstein's theory of gravity: The general theory of elativity, a.k.a. GR. We will first recap special relativity and learn to express the theory in terms of tensors. We will then learn how to mathematically express concepts of curvature in terms of tensors (known as differential geometry). Once we understand how to quantify curvature we will derive the Einstein field equations. We will then (as time permits) explore several important solutions of the field equations the describe neutron stars, black holes, the expanding universe, and gravitational waves.

What to Expect:

This course will require you to carry out numerous homework assignments that are highly mathematical in nature. Weekly problem assignments will be handed out that will reinforce the material presented during the lecture. This course will involve a lot of mathematics that will be new to you. If you don't like doing quite a lot of math this course is not for you!

Required text: "A First Course in General Relativity" by Bernard Schultz, ISBN-13: 978-0521887052)

Course Grading & Attendance:

The grading for the course will be based on the completion of weekly homework assignments (1/3) , a midterm exam (1/3), and a final exam (1/3). Each of these components will count equally towards the final grade. **The course grades are curved.**

If an absence occurs causing you to miss an exam or homework assignment due to a legitimate reason (illness, medical issue, death of a family member, jury duty, military service) please provide full documentation of the reason to the Office of the Dean of Students (222 Students Activities Center, 631-632-7320) and ask them to contact your instructors.

Important University Policies:

Student Accessibility Support Center (SASC) Statement:
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact the Student Accessibility Support Center (SASC), 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. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the staff at the Student Accessibility Support Center (SASC). For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities

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.

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

SPECIAL NOTE REGARDING PLAGIARISM AND DISHONESTY: All instances of suspected plagiarism or academic dishonesty will be brought before the Academic Judiciary Committee. All parties suspected (both the copier and the person who produced the original work) will be held accountable for any instance of plagarism or dishonesty. You are responsible for protecting the security of your programming assignments by making sure that your directories are not world readable. If you are unsure how to secure your home directory see the instructor immediately.

Important Course Policies:

- **Student Responsibilities.**You will be expected to abide by by all University regulations, procedures, requirements, and deadlines as described in the *Undergraduate Student Bulletin.*

- **Attendance.** As per the University policy outlined in the *Undergraduate Student Bulletin*, students are expected to regularly attend all classes and to participate in the classroom experience.

- **Classroom Behavior and Conduct**
  You are expected to conduct yourself in accordance with the minimal undergraduate student responsibilities described in the Undergraduate Student Bulletin including:
  - You are expected to arrive for class promptly.
  - Avoid behavior that is disruptive to the classroom especially the use of cell phones.
  - Avoid web surfing during class.
  - Be familiar with material presented in previous lectures.

Lecture, Homework, and Exam Schedule:

A tentative lecture schedule is given below but is subject to change. Any changes to this schedule will be made to the version of this schedule posted on the course web site. The homework assignments will also be posted on the course web site. The mid-term examination date is included in the lecture schedule below. The final examination will be held at the time scheduled by the registrar. It is the students responsibility to schedule classes so as to avoid final examination conflicts.

Note: You must take the exams during the time scheduled for your section. Failure to do so will mean your exam will not be graded and your exam will receive a score of zero

Date	Topic
Lecture 1	Special relativity. Schutz 1.1-1.4

Lecture 2	Special relativity. Schutz 1.5-1.10
Lecture 3	Vector analysis. Schutz 2.1-2.5
Lecture 4	Vector analysis. Schutz 2.5-2.7
Lecture 5	Tensor analysis. Schutz 3.1-3.4
Lecture 6	Tensor analysis. Schutz 3.5-3.8
Lecture 7	Fluids in special relativity. Schutz 4.1-4.4
Lecture 8	Fluids in special relativity. Schutz 4.5-4.8
Lecture 9	Calculus on curved surfaces. Schutz 5.1-5.5
Lect. 10	Calculus on curbed surfaces. Schutz 6.1-6.3
Lect. 11	Quantifying curvature Schutz 6.4
Lect. 12	Quantifying curvature. Schutz 6.5
Lect. 13	Quantifying curvature. Schutz 6.6
Lect. 14	Midterm exam
Lect. 15	Quantifying curvature. Schutz 6.6-6.7
Lect. 16	Physics in curved spacetime. Schutz 7.1-7.2
Lect 17.	Physics in curved spacetime. Schutz 7.3-7.4
Lect. 18	The Einstein field equations. Schutz 8.1-8.2
Lect. 19	The Einstein field equations. Schutz 8.3-8.4
Lect. 20	Spherical solutions for stars. Schutz 10.1-10.2
Lect. 21	Spherical solutions for stars. Schutz 10.3-10.4
Lect. 22	Spherical solutions for stars. Schutz 10.3-10.4
Lect. 23	The Schwarschild solution & black holes: Schutz 11.1-11.2
Lect. 24	The Schwarschild solution & black holes. Schutz 11.3
Lect. 25	Real black holes. Schutz 11.4
Lect. 26	Cosmology & the FRW Solution (if time permits). Schutz 12.1-12.2
Lect. 27	Cosmology & the FRW Solution (if time permits). Schutz 12.3
Lect. 28	Gravitational Waves (if time permits). Schutz 9.1, 9.3-9.4
Date scheduled by Registrar	**Final Exam (Check Registrar's Final Examination Schedule at http://www.stonybrook.edu** **Note: It is the students responsibility to schedule classes so as to avoid final exam conflicts. No conflict exams will be given**