Physics 23200: Honors Intermediate Seminar: Relativity and Quantum Physics in Society
Spring 2010
T, Th 9:25 - 10:40
Room: CNS 206
Prerequisite: MATH-11200 (Calc II)

Professor:	Matthew C. Sullivan Office: CNS 262 or CNS 278 (lab) Phone: 274-3964 email: mcsullivan@ithaca.edu
Office Hours:	T/Th 11 AM - 12 PM, M/W 1-2 PM and by appointment
Required Texts:	**Time for the Stars**, Robert Heinlein **Quarantine**, by Greg Egan **Quantum Gods**, by Victor J. Stenger **The Quantum Enigma**, Rosenblum and Kuttner
Recommended Texts:	**Schaum's Outlines: Modern Physics** **Modern Physics**, Kenneth Krane (2nd edition)
Web Resources:	Course web page on the Physics website (under Courses)

Course Philosophy:
Special relativity and quantum mechanics are the backbone of modern physics and the basis for one-third of our current economy, yet are poorly understood and often misinterpreted by the general public. This course is intended to introduce students to these two fascinating topics.

The course is split into three pieces. First, we must learn special relativity (SR) and quantum mechanics (QM), and I will introduce these topics and show you some of the predictive power of these theories. Keep in mind that even though these are theories, they have never been proven wrong, and they are the most tested scientific theories ever! Second, we will explore how SR and QM are used in modern society, and also viewed in modern society. Finally, we will explore some of the true philosophical and existential problems that SR and QM in particular bring up. These problems are acknowledged by physicists but are ignored due to the fact that predictions based on SR and QM have never been proven wrong.

I believe that in order to learn physics you must do physics – whether this is completing an assigned homework problem or actively engaging in a discussion about the physics we're trying to learn. Doing physics does not entail listening to me lecture for hours on end. Doing physics is thinking about and applying concepts, problem solving skills, mathematical tools, reasoning skills, and critical thinking skills. This course will require you to be an active participant, which will result in a more enjoyable and rewarding course for you and me.

The course goals are:

- To acquaint students with special relativity and quantum mechanics,
- To learn how special relativity and quantum mechanics are used in modern society,
- To learn how special relativity and quantum mechanics are viewed in modern society,
- To discuss the philosophical and existential problems in special relativity and quantum mechanics.
- To become better problem solvers and critical thinkers using special relativity and quantum mechanics as the means to do so.

In addition, this class satisfies General Education credit in the School of Humanities and Sciences, area 2a: Science. In particular, this course satisfies the following General Education goals:

- Students will develop an understanding of some basic scientific principles (special relativity and quantum mechanics),
- Students will develop an appreciation for the relevance of science to society, as well as some comprehension of the interaction of humans and the natural and physical world.

Grading

The grades in this course will be based on the following items:

Participation:	10%
Homework:	10%
Midterm Exam:	20%
Midterm Project/Paper:	25%
Final Paper Outline:	3%
Final Paper:	32%

The IC grading scale is as follows: A: 90-100, B: 80-89, C: 70-79, D: 60-69, F: $<$60.

Homeworks

For the first section of class, I will assign a problem set every week. Homework will be due every Thursday at the **beginning** of class. *Late homework will not be accepted*. I recognize that students will get overworked at certain points during the semester, so every student gets 1 five-day extensions: You may have an extension until Tuesday at the start of class. The only catch: You have to ask for the extension by 4 PM the day before – you cannot show up to class and expect to get an extension.

Regarding homework, I encourage you to work together when trying to understand a problem, but the work you hand in must be your own. I suggest you work out the problem in groups, then write your solution up neatly at home. This will reinforce the problem, and will make it clear if there are any gaps in your understanding.

Homework problems will be worth 6, 9, or 12 points depending on the difficulty of the problem. You will be graded on the concepts as well as your ability to solve the problem mathematically. Also, three of the points will be awarded as follows: 2 points for neatness and clarity, and 1 point for drawing a picture. The beauty of physics is that we have a real, physical problem we

are trying to solve, so draw the picture of that problem! And writing legible solutions that I can follow is excellent practice for the exams.

I will return the homeworks within a week after the homework is due.

Midterm Exam

The midterm exam will contain conceptual questions as well as traditional word problems. The purpose of the exam is to make sure all students in the course have the same understanding of SR and QM – We cannot intelligently discuss how society views these topics if we do not understand them ourselves.

Please note that the midterm exam is already scheduled, and thus you should adjust your schedule to avoid any conflicts.

I will return the exam within 10 days after the exam is scheduled.

Midterm Project/Paper

In the second section of the class we will learn how modern society uses SR and QM in technology, how it views these subjects, and also it uses to justify any number of different things (from religion to automobiles). This section of class will culminate in an open-ended project or paper. In this project, you must find a source (this can be a book, a novel, a movie, or even – heavens forfend – a website) that deals with special relativity and/or quantum mechanics. You will study this source, and then ask and answer questions. Does your source correctly deal with the science? What does it get right or wrong? What ends is this source trying to accomplish using SR/QM as the means? Is the source effective? How does this source relate to other sources we have studied?

This section of the course will culminate in a written paper or visual presentation. Visual presentations will be presented to the class on the date listed in the schedule. The week before the project/paper is due, you must meet with me so we can go over the ideas and the scope of your project/paper. Presentations will be roughly 10 minutes in length, and written papers will be 5-7 pages long.

You will receive feedback on the project/presentation within 10 days after the project is due.

Final Paper

Special relativity and quantum mechanics in particular creates several rather difficult issues to deal with. These problems are acknowledged by physicists but are usually ignored due to the fact that predictions based on SR and QM have never been proven wrong. These problems include the measurement paradox and the entanglement of human consciousness into the physical system being measured. In the third section of the course we will discuss these issues at length.

This section of the course will culminate in a final paper between 10 and 12 pages long. In this paper, you must attempt to tackle one of these outstanding issues in SR and QM. In your final paper, you will clearly articulate the issue using a variety of sources, and then attempt to come to terms (and resolve?) the problem.

During the final week of classes, you must submit a bulleted outline of your final paper, which I will edit and return to you. The outline is worth 3% of your final grade. The final paper is due

on our last day of class during our final exam time.

Attendance

Students are required to attend all scheduled class meetings.

If you miss class due to your religious beliefs you are excused from class on that day. I will work with you to provide you with an equivalent opportunity to make up any examination, study or work requirement which the you may have missed. I suggest that you notify me at least one week before any anticipated absence so that proper arrangements may be made to make up any missed work or examination. Any such work is to be completed within a reasonable timeframe, (as determined by me).

If you miss class due to a family or individual health emergency, or to a required appearance in a court of law, you are excused from class on that day. You or a family member/legal guardian may report the absence to the Office of Student Affairs and Campus Life, which will notify the students deans office, as well as residential life if the student lives on campus. The deans office will disseminate the information to the appropriate faculty. Follow-up by the student with his or her professors is imperative. You may need to consider a leave of absence, medical leave of absence, selected course withdrawals, etc., if they have missed a significant portion of class work.

Academic Honesty

Please familiarize yourself with the Ithaca College Student Code of Conduct; specifically the Standards of Academic Conduct (`http://www.ithaca.edu/attorney/policies/vol7/Volume_7-70104.htm`). I hold all students to these standards. I do not tolerate cheating or plagiarism of any kind. I will forward all academic conduct cases to the academic judicial review board. It is their job to handle these issues.

I do encourage students to work with each other because this is a great way to learn physics, but in the end the work you hand in must be your own. A successful strategy is to discuss approaches to a solution with other students or professors, but then go off on your own to write up the final solution. This way your solution will be in your voice and not a copy of another students solution.

For your papers and projects, those must be your own thoughts, ideas, and work. I will not tolerate plagiarism.

Extra Credit

There will be extra credit offered in this course.

Extra credit will be offered to students who attend **at least four** Physics Department seminars. The seminars are held every other Tuesday from 12:05-1:10 PM. This course is about special relativity and quantum mechanics in modern society – what better way to learn this than to hear professors speak about their work in the field? All modern physics deals in some way with quantum mechanics.

Advice from previous students in my courses:

Here is some advice from previous students my courses. Please heed their advice, it will help you in this course.

- Start the homework early
- Be prepared to attend class every day and work hard
- Do the reading assignments
- Go in for help as soon as you're having trouble or it will accumulate
- Listen to the advice from previous students that they give you in the syllabus

Other notes:

- In compliance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act, reasonable accommodation will be provided to students with documented disabilities on a case-by-case basis. Students must register with the Office of Academic Support Services and provide appropriate documentation to the College before any academic adjustment will be provided.
- Students performing below a C will be asked to meet with the professor to discuss a course of action that will bring the student's grade up.
- I will send out occasional emails to the entire class to their *Ithaca College* email addresses, so you must check them regularly.
- Final grades are FINAL – no work may be handed in for additional credit after the final exam.

Course Outline:

Below is a rough outline of the course. There will be modifications to this outline depending on how fast we cover the material.

No	Day	Reading	Topic	Work due
1	Jan 26	No reading	Galilean transformations	
	Jan 28	Shaum's, Ch. 1,2	Relativistic transformations	
2	Feb 2	Shaum's, Ch. 3,4	Length Contraction, time dilation	
	Feb 4	Shaum's, Ch. 5,6	Worldlines, twin paradox	Problem Set 1
3	Feb 9	Schaum's, Ch. 9	Birth of Quantum Mechanics	
	Feb 11	Schaum's, Ch. 10	Schrödinger's equation	Problem Set 2
4	Feb 16	No reading	Using Schrödinger's equation: 1-D	
	Feb 18	Schaum's, Ch. 11	The Hydrogen atom	Problem Set 3
5	Feb 23	Schaum's, Ch. 13	Spin	
	Feb 25	Schaum's, Ch. 14	Particle in a box	Problem Set 4
6	Mar 2	No reading	Bell's inequalities and non-locality	
	Mar 4	No reading	**Midterm Exam, in class**	
7	Mar 9	Time for the Stars	Relativity in	
	Mar 11	Time for the Stars	Science Fiction	
	Mar 13-21		Spring Break	
8	Mar 23	Quarantine, Pt 1	Quantum Mechanics in	
	Mar 25	Quarantine, Pt 2	science fiction	
9	Mar 30	What the BLEEP do we know?	Quantum	
	Apr 1	No reading	Spirituality	
10	Apr 6	Quantum Gods, Ch.1-3	Quantum Physics and	
	Apr 8	Quantum Gods, Ch.3-5	religion	
11	Apr 13	No reading	Project/Paper meetings (no class)	
	Apr 15	No reading	Project/Paper presentations	Midterm Project/Paper
12	Apr 20	Quantum Enigma, Ch.1-3	Quantum Mechanics	
	Apr 22	Quantum Enigma, Ch.4-6	for the masses	
13	Apr 27	Quantum Enigma, Ch.7-10	Interpretations of	
	Apr 29	Quantum Enigma, Ch.11-13	Quantum Mechanics	
14	May 4	Quantum Enigma, Ch.14-17	EPR paradox, Bell's inequalities	Final Paper Outline
	May 6	No reading	Consciousness and QM	
15	May 10	None		Final Paper Due at 7 PM

Last revised on January 25, 2010.