25 Science, Philosophy, and the Big Questions

Christian Wüthrich Winter 2012

Class schedule:	TuTh 5:00-6:20pm, PETER 104
Sections:	A01: W 12:00-12:50pm, HSS 1315
	A02: F 12:00-12:50pm, HSS 2150
Website:	`http://philosophy.ucsd.edu/faculty/wuthrich/`
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The revolution in physics during the first three decades of the twentieth century swept away the intuitive and palatable theories of classical physics and brought forth the puzzling and seemingly paradoxical new theories of special and general relativity as well as of quantum mechanics. Modelled on John Norton's *Einstein for Everyone*, this course will introduce and explain the exciting and important ideas at the core of this revolution to students with little or no background in physics. Focusing on Albert Einstein in particular, it will answer many questions you had about Einstein and his singular achievements but never dared to ask. It is perfect for everyone who understands that Einstein's work in the foundations of physics has forever changed physics and the way we think about our world, but never had a chance to explore just how it did so.

We will approach Einstein's theories with a trifold interest in their science, their philosophy, and their history. Naturally, there will be quite a bit of straight exposition of the physics of special relativity, general relativity, and quantum theory. We will also be tracing the revolution's history and analyze and discuss the philosophical underpinnings and consequences of the new theories. This will lead us to deep philosophical questions about space, time, causality, the constitution of matter, and determinism, as well as to the measurement problem in quantum mechanics which challenges the very way in which physical existence was cast since Aristotle's time.

Prerequisites: None.

Course materials

- John Norton, *Einstein for Everyone*, available at `http://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/index.html`.
- You will need to purchase an **i>clicker**, the student response system used in this class. These 'clickers' are available at the Price Center bookstore and cost $46.75 (new) or $35.10 (used). Make sure to get an i>clicker and not a different system such as H-ITT or PRS. For more information, visit `http://mediaservices.ucsd.edu/clickers`.

Course requirements and evaluation

The grade for this course will be determined by the total points a student earns from the three types of evaluation indicated below. I grade to the curve, i.e., the top 25-30% of the students in this class (including all who take it for a letter grade or a P/NP, but not including the withdrawals W) will get a grade in the A range (A+, A, A-), the next 25-35% a grade in the B range (B+, B, B-), the next 25-30% a grade in the C range (C+, C, C-), and the remaining 5-25% a D or an F. This is the minimum I guarantee; if the class has worked very well and no one deserves a D or an F, I will adjust the curve upwards, accordingly.

1. *Participation* (20 points): Your 'clicker' score will be based on in-class questions scored using the student response system. During each class (except the first), I will ask you to 'buzz in' and the system will automatically record your responses, and then transmit it to me. Perhaps twice or so during classes, I will put up a short quiz or poll for you to answer. Your clicker score will be the percentage of points earned divided by the maximum possible. **Important: you must have your clicker every class period to get these points—no exceptions**.

2. *Assignments* (25 points): There will be an **assignment** due each week in section. Each problem is worth up to one point. There will be more than 25 problems, allowing you to skip a small number.

3. *Quizzes* (25 points): There will be **six short quizzes** during the quarter, each worth 5 points, but only the best five of six count toward your grade. The quizzes will be announced in class one meeting before they will be held. No make-up quizzes will be given.

4. *Final exam* (30 points): There will be a **final exam** on TBD, in a location to be announced. You are not allowed to use any books or notes or the like, i.e. the exam is 'closed-books'. The final exam is cumulative, i.e. it covers all the material of the entire course.

The fine print

Students agree that by taking this course all required papers will be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the terms of use agreement posted on the Turnitin.com site.

You must observe the University's Policy on Integrity of Scholarship, which can be found at `http://senate.ucsd.edu/AcademicIntegrity/AcademicIntegrity.htm`.

Make-up exams will only be given under the most severe circumstances. The student who wishes to write a make-up exam must inform me (by phone or email) ahead of the time of when the exam is due (papers) or takes place (in-class exams). In order to qualify for a make-up exam, appropriate evidence of the most severe circumstances must be produced by the student. I will determine, in consultation with the student, what qualifies as appropriate evidence.

Tentative schedule

Final Exam: Thursday, 22 March 2012, 7:00-9:59pm

Date	Topic and reading assignments
10 Jan	Introduction: the questions
12 Jan	Special relativity: the basics Special relativity: adding velocities
17 Jan	Special relativity: the relativity of simultaneity
19 Jan	Is special relativity paradoxical? $E = mc^2$
24 Jan	Origins of special relativity Einstein's pathway to special relativity
26 Jan	Spacetime Spacetime and the relativity of simultaneity
31 Jan	Spacetime, tachyons, twins and clocks
2 Feb	What is a four dimensional space like?
7 Feb	Philosophical significance of the special theory of relativity
9 Feb	Euclidean geometry: the first great science Non-Euclidean geometry: a sample construction
14 Feb	Spaces of constant curvature Spaces of variable curvature
16 Feb	General relativity
21 Feb	Gravity near a massive body
23 Feb	Einstein's pathway to general relativity
28 Feb	Relativistic cosmology Big bang cosmology
1 Mar	Black holes A better picture of black holes
6 Mar	Atoms and the quantum Origins of quantum theory
8 Mar	Quantum theory of waves and particles
13 Mar	The measurement problem Einstein on the completeness of quantum theory
15 Mar	Einstein as the greatest of the nineteenth century physicists