HSCI 1905–SECTION 001/PHYS 1905–SECTION 004

EINSTEIN FOR EVERYONE

FALL 2007

TIME AND PLACE: Wednesdays, 9:05–11:00 AM, Tate Lab of Physics, Rm. 236A

INSTRUCTOR: Michel Janssen, Tate Lab of Physics, Rm. 354B. Tel. 4 5880. Email: janss011@umn.edu. Office Hours: W, 11:00 am–12:00 pm; Th, 11:00 am–12:00 pm; or by appointment.

COURSE DESCRIPTION: The aim of this seminar is to introduce you to Albert Einstein (1879–1955) and his science. Throughout the seminar the use of mathematics will be kept to an absolute minimum. You will need no more than some basic high-school algebra and geometry. We begin by studying the special theory of relativity (1905) and some of its famous predictions such as time dilation, the twin paradox, and $E=mc^2$. To help you get comfortable with the material, I will have you do a number of short exercises that we shall carefully analyze in class. While working our way through this material, we will also look at elements of 19th-century physics that played a role in the development of special relativity. We continue to pursue a historical approach when we turn to the general theory of relativity (1915), the theory that makes gravity part of (curved) space-time. We trace the development of this theory from 1907 till about 1920. Einstein worked intensively on this theory living in Berlin during the first World War (1914–1918). For this period, we shall also take a close look at Einstein's personal life (the messy divorce from his first wife and his second marriage to his cousin) and at his tentative first appearances on the political stage (pacifism, zionism). The last two sessions of the class will be devoted to Einstein's attitude towards quantum mechanics. By the end of the course you should have a good understanding of some of Einstein's most revolutionary ideas, of how he arrived at them, at what personal price, and in what broader socio-political and cultural context.

REQUIREMENTS: the basic requirements for this class are that you keep up with the readings and that you participate actively in class. Do the readings for any given week (with the obvious exception of the first) before you come to class, so that you are well prepared to follow the lecture and to participate in discussion. Other than that, there will be five homework assignments. The last assignment (HW#5) will involve writing of and acting in part of a screenplay based on a treatment I wrote together with my former boss at the Einstein Papers Project for a movie about Einstein. Friends and family are welcome to attend. Coffee and bagels will be provided.

GRADING: Your grade will be based on attendance (30%), class participation (30%), and homework assignments (40% total: 5% each for HW#1–HW#4 and 20% for HW#5). All grades will be given as point grades on a scale from 40 to 100. The conversion to letter grades will roughly be as follows: 85–100: A; 70–85: B; 55–70: C; 40–55: D; less than 40: F.

POLICIES:

Attendance: Since the discussion of the assigned readings in class is an integral part of the course, attendance is mandatory. Attendance will be taken at the beginning of each class. Unexcused absences will be reflected in your grade.

Late Homework Policy: Since we will be discussing the homework assignments in class the day they are due, I cannot give full credit for assignments handed in late. Still, turning in an assignment late is better than not turning it in at all. For that reason, you will still get partial credit for late assignments. Provided that your work shows that you have understood the essence of the material tested by the assignment, you will receive a point grade of 80 (or a B) for late assignments. If you got a point grade of less than 80 for an assignment, you can always hand in a corrected version to bring your grade up to 80.

Office Hours: If you have difficulty with the material (or you just want to chat about the class, or about becoming a physics major or doing a minor in history of science and technology) come see me during office hours. I will do my best to answer any questions you may have, from very specific ones to "I'm lost!"

COURSE MATERIALS:

- Banesh Hoffmann, *Albert Einstein: Creator and Rebel*. New York: Viking.
- Dennis Overbye, *Einstein in Love: A Scientific Romance*. New York: Viking.

The Overbye book is available at the U of M bookstore in Coffman Union. The Hoffmann book is currently out of print. The relevant parts will be made available as pdf files on the website for the class (see below). Most of the class will be taught from handouts. These will also be made available to you via the website of the course. I will provide hard copies of the most important ones free of charge.

WEBVISTA COURSE SITE

To log on to the WebVista course site for this class, go to www.myu.umn.edu. Sign in to "myu." You will be prompted for your UofM Internet ID (i.e., your username as in username@umn.edu) and password (if you do not know your Internet ID or have forgotten your password, call the ADCS helpline at 626-4276). Go to the tab "my courses." There you will find a list of all WebVista sites for courses that you are currently enrolled in. Click on the link to this course. The first time you use WebVista, go to webvista.umn.edu and follow the instructions on configuring your browser (this site also provides an alternative path to WebVista course sites: go to WebVista B and log in). All files on the course site are in html- or pdf-format. To read and print pdf files, you need Adobe Acrobat Reader. For instructions on how to download this program for free, go to http://www.adobe.com/products/acrobat/readstep2.html. There is a link to this site on the home page of the course site.

SCHEDULE

The readings for this class fall into two categories. First, there is material dealing with aspects of relativity theory, its conceptual basis and its historical development. This material you need to study very carefully. For any given week, I tried to keep this type of reading to a minimum to make sure you have time to fully digest it. The other type of reading deals with Einstein's life and career. This should be relatively light reading. We shall be reading parts of two very different Einstein biographies, an older one by the physicist Banesh Hoffmann, who knew Einstein personally, and a more recent one by New York Times science journalist

Dennis Overbye. As you are reading these two sources, ask yourself how the pictures of Einstein as a person and as a scientist painted by these two authors differ from one another. The seminar, like Overbye's book, focuses on the first half of Einstein's life (until about 1920). This corresponds to chapters 1–8 in Hoffmann's book. You are encouraged, but not required, to read the remaining chapters.

Week 1	September 5, 2007
The Postulates of Special Relativity I: Relativity of Simultaneity.	

Week 2	September 12, 2007
The Postulates of Special Relativity II: Time Dilation and Length Contraction **Historical aside: 19th-century ether theory, Michelson-Morley experiment, Lorentz-FitzGerald contraction.**	
Readings	Handout, "Albert Einstein: His Biography in a Nutshell."
	Handout, "Special Relativity", secs. 1.1–1.4, pp. 1–16.

Week 3	September 19, 2007
The Postulates of Special Relativity III: The Velocity Addition Theorem **Historical aside: Fresnel drag coefficient, Fizeau experiment, and the addition theorem of velocities.**	
HW#1 due	Relativity of Simultaneity, length contraction, and time dilation
Readings	Handout, "Special Relativity", sec. 1.5, pp. 17–19
	Hoffmann, chs. 1–6, pp. 3-82

Week 4	September 26, 2007
Special Relativity and Minkowski Space-Time I: Space-Time Diagrams, Relativity of Simultaneity, Tachyons and Causal Paradoxes	
Readings	Handout, "Special Relativity", secs. 2.1–2.3, pp. 20–30.
	Hoffmann, ch. 7, pp. 83–101

Week 5	October 3, 2007
Special Relativity and Minkowski Space-Time II: Time Dilation and Length Contraction	
Readings	Handout, "Special Relativity", sec. 2.4, pp. 30–34.
	Overbye, Pt. I, chs. 1–5, pp. 3–65

Week 6	October 10, 2007
Special Relativity and Minkowski Space-Time III: Pythagorean Theorem in Minkowski Space-Time	
HW#2 due	Drawing space-time diagrams
Readings	Handout, "Special Relativity", secs. 2.5–2.6, pp. 34–42.
	Overbye, Pt. II, chs. 6–10, pp. 69–140.

Week 7	October 17, 2007
The Twin Paradox; History of Special Relativity I	
HW#3 due	Two Relativity Puzzles: the Pole and the Barn; the Pair of Rockets Connected by a Rope
Readings	Handout, "Special Relativity", secs. 2.7, pp. 42–45.
	Entry on "Relativity" in *New Dictionary of the History of Ideas*, pp. 1-9.

Week 8	October 24, 2007
History of Special Relativity II	
Reading	Overbye, Pt. III, chs. 11–15, pp. 143–218.

Special events this week in connection with 'Time and Relativity,' a symposium organized by the University of Minnesota's Institute for Advanced Study

Thursday, October 25, 4:00 pm (Nolte, Rm. 125): "What Einstein Did to Time": Conversation between Oliver Pooley (Oxford University) and Michel Janssen

Thursday, October 25, 7:30 pm (Nicholson Hall, Rm. 275): Harvey Brown (Oxford University) "Kinematics versus dynamics: putting Einstein's 1905 relativity paper in historical context."

Week 9	October 31, 2007
NOVA Special: "Einstein Revealed" (Video).	
Reading	Overbye, Pt. IV, chs. 16—21, pp. 221—309.

Week 10	Novbember 7, 2007
$E=mc^2$; 'There's No Success Like Failure:' Einstein's Quest for General Relativity I	
HW#4 due	Review of NOVA Special OR short essay on the symposium 'Time and Relativity'
Readings	Handout, "The Trouton Experiment and $E = mc^2$."
	Entry on "Relativity" in *New Dictionary of the History of Ideas*, pp. 9–16.
	Hoffmann, ch. 8, pp. 103–133.

Week 11	November 14, 2007
Einstein's Quest for General Relativity II	
Readings	Entry on "Relativity" in *New Dictionary of the History of Ideas*, pp. 16-20.
	Overbye, Pt. V, chs. 22–25, pp. 313–372.

Week 12	November 21, 2007
Einstein's Quest for General Relativity III: The Einstein-Besso Manuscript	
Readings	Handout, "The Einstein-Besso Manuscript: Looking Over Einstein's Shoulder."
	Overbye, Epilogue, pp. 373–380.

Week 13	November 28, 2007
Einstein in Berlin During the First World War	
HW#5 due	Prepare a script for acting out one or two scenes of the Einstein movie treatment.
Reading	Michel Janssen and Robert Schulmann, "Master of the Universe—Treatment for a Movie about Albert Einstein."

Week 14 & 15	December 5 & 12, 2007
Einstein and Quantum Mechanics	
Reading	David Z. Albert, *Quantum Mechanics and Experience*. Cambridge, MA: Harvard University Press, 1992. Ch. 1, pp. 1—16 ("Superposition")