

## HONORS PS1500 - It's About Time

### Course Outline - Spring Semester 2005

**INSTRUCTOR:** Dr. Bradley W. Carroll  
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**COURSE**  
**HOMEPAGE:** <http://physics.weber.edu/carroll/honors-time/>  
**TEXTS:** *Seven Ideas that Shook the Universe*, Nathan Spielberg and Bryon D. Anderson;  
*Measuring Eternity*, Martin Gorst;  
*Einstein's Dreams*, Alan Lightman;  
*Tom Stoppard: Plays Five*, Tom Stoppard;  
*Readings: It's About Time*

**Science and math background assumed:** none!

### OUTLINE

St. Augustine said of time, "I know well enough what it is, provided that nobody asks me; but if I am asked what it is and try to explain, I am baffled." In this class we will examine our understanding of time, from the ancient Greeks through Einstein's relativity. We will examine our own perceptions of time and those of other cultures as we explore deep geological time and even deeper cosmological time. Along the way we will do experiments, watch a movie, read a play, and admire works of literature, art, and music.

### OFFICE HOURS

10:00 - 11:00 daily  
and  
any other time I am in my office

Do the assigned reading and **come prepared** to discuss any of the topics. The midterms will consist of multiple-choice and short answer questions, and will be given in the Student Service Testing Center (SC 269) over a two-day period; remember to bring a picture ID and a #2 pencil for the multiple-choice. Each person is responsible for his or her own work. Academic dishonesty on any exam will result in a grade of zero being given for that examination. A second violation will constitute failure of the course.

Physics provides the fundamental description of physical reality, an exciting and sometimes startling view of the world that most people never get to see. Above all, **Ask Questions at Any Time!** If you have questions that can't be cleared up in class, drop by my office anytime to discuss the meaning and implications of the material. Relax and enjoy this exploration of time, and remember the words of British scientist J. B. S. Haldane: "Not only is the universe stranger than we imagine, it is stranger than we *can* imagine!"

#### GRADING

- "A": An overall midterm average of at least 80% *and* an acceptable approved project for a total of at least 90% (midterms + project) *and* a satisfactory effort in group discussion
- "B": An overall midterm average of at least 80% *and* a satisfactory effort in group discussion
- "C": An overall midterm average of at least 70% *and* a satisfactory effort in group discussion
- "D": An overall midterm average below 70% *or* an unsatisfactory effort in group discussion
- "E": An overall midterm average below 70% *and* an unsatisfactory effort in group discussion

The course project is worth up to 10%. It should be something original and creative, and must be at least peripherally related to the subject matter of the course. With your project you must hand in a short written paper that describes what you did and how it is connected to the course. No last-minute projects will be approved. Your project should be something we can both be proud to share with the rest of the class!

## SCHEDULE AND READING ASSIGNMENTS

Date	Topic	Reading Assignment for this Class
Jan 10	Introduction	
Jan 12	Greek Astronomy	<i>Seven Ideas</i> , p. 14-29
Jan 14	Time for Plato and Aristotle	Plato: <i>Timaeus</i> , Sec. 3-5, 7, 21; Plato: <i>Plato's Cave</i> ; Aristotle: <i>Physics</i> , Book IV, 10-14; Aristotle: <i>On Coming-to-Be and Passing-Away</i>
Jan 17	<b>Martin Luther King Holiday</b>	
Jan 19	Augustine and Time	Augustine: <i>Confessions</i> , Book XI; <i>Measuring Eternity</i> , Ch. 1
Jan 21	World Cultures and Time	Ezzell: <i>Clocking Cultures</i>
Jan 24	Copernicus and Kepler	<i>Seven Ideas</i> , p. 29-49
Jan 26	Aristotle's Physics and Galileo	<i>Seven Ideas</i> , p. 50-70; <i>Measuring Eternity</i> , Ch. 2-4
Jan 28	Water Clock and Pendulum	Galileo: <i>Letter to the Grand Duchess Christina</i>
Jan 31	Newton's 1 <sup>st</sup> and 2 <sup>nd</sup> Laws	<i>Seven Ideas</i> , p. 70-74
Feb 2	Newton's 3 <sup>rd</sup> Law and Momentum	<i>Seven Ideas</i> , p. 74-78
Feb 4	Newton's Law of Gravity	<i>Seven Ideas</i> , p. 78-83; Nagel: <i>Free Will</i>
Feb 7	Dividing Time: Clocks and Music	Andrewes: <i>A Chronicle of Timekeeping</i> ; Crosby: <i>Time</i> ; Crosby: <i>Music</i>
Feb 9	Geological Time	<i>Measuring Eternity</i> , Ch. 5-9
Feb 11	Kinetic, Potential, and Thermal Energy	<i>Seven Ideas</i> , p. 84-100

Feb 14	Conservation of Energy	<i>Seven Ideas</i> , p. 100-105; <i>Measuring Eternity</i> , Ch. 10
Feb 16	Heat Engines	<i>Seven Ideas</i> , p. 106-124
Feb 18	Entropy and the Arrow of Time	<i>Seven Ideas</i> , p. 124-138; Byron: <i>Darkness</i>
Feb 21	<b>Presidents' Day Holiday</b>	
Feb 23	Algorithms and Chaos	Hall: <i>Exploring Chaos</i>
Feb 25	<i>Arcadia</i> 1	<i>Arcadia</i> , Act 1, Scene 1
Feb 28	<i>Arcadia</i> 2	<i>Arcadia</i> , Act 1, Scene 2
Mar 2	<i>Arcadia</i> 3	<i>Arcadia</i> , Act 1, Scenes 3 and 4
Mar 4	<i>Arcadia</i> 4	<i>Arcadia</i> , Act 2, Scenes 5 and 6
Mar 7	<i>Arcadia</i> 5	<i>Arcadia</i> , Act 2, Scene 7
Mar 9	Biological Clocks	Whitrow: <i>Biological Clocks</i> ; Wright: <i>Times of Our Lives</i>
Mar 11	The Perception of Time	Sacks: <i>The Lost Mariner</i> ; Sacks: <i>A Matter of Identity</i> ; Damasio: <i>Remembering When</i> ; Pickover: <i>The Brain's Time Machine</i>
Mar 14 - 18	<b>Spring Break</b>	
Mar 21	Dating Techniques	<i>Measuring Eternity</i> , Ch. 11; <i>Einstein's Dreams</i>
Mar 23	What is Light?	<i>Seven Ideas</i> , p. 139-155
Mar 25	Einstein's Two Postulates and the End of Simultaneity	<i>Seven Ideas</i> , p. 156-165; J. Schwartz & M. McGuinness: <i>The Relativity of Simultaneity</i>
Mar 28	Time Dilation and Length Contraction	<i>Seven Ideas</i> , p. 165-168
Mar 30	Twin Paradox, $E = mc^2$	<i>Seven Ideas</i> , p. 169-174
Apr 1	General Relativity	<i>Seven Ideas</i> , p. 174-183

Apr 4	Art and Physics	Shlain: <i>Cubism/Space</i> ; Shlain: <i>Futurism/Time</i>
Apr 6	Blackbody Radiation and Photons	<i>Seven Ideas</i> , p. 184-199
Apr 8	The Bohr Atom	<i>Seven Ideas</i> , p. 199-205
Apr 11	Matter Waves and Probability	<i>Seven Ideas</i> , p. 205-216
Apr 13	The End of Determinism	<i>Seven Ideas</i> , p. 216-224; Feynman: <i>Probability and Uncertainty</i>
Apr 15	Stars and Stellar Evolution	Ferris: <i>The Evolution of Atoms and Stars</i>
Movie Night!	"Frequency" and/or "The Time Machine"	Bradbury: <i>A Sound of Thunder</i> ; Hilton-Young: <i>The Choice</i>
Apr 18	Black Holes	Pasachoff & Filippenko: <i>Black Holes</i> ; Davies: <i>How to Build a Time Machine</i>
Apr 20	The Expanding Universe	<i>Measuring Eternity</i> , Ch. 12, 13; Pasachoff & Filippenko: <i>A Universe of Galaxies</i> , p. 315-318 & p. 330-335
Apr 22	The Big Bang and Nucleosynthesis	<i>Measuring Eternity</i> , Ch. 14; Pasachoff & Filippenko: <i>Cosmology</i> , p. 365-377; Pasachoff & Filippenko: <i>In the Beginning</i> , p. 391-402
Apr 25	The Formation of Structure in the Universe	Pasachoff & Filippenko: <i>A Universe of Galaxies</i> , p. 321-330 & p. 335-338
Apr 27	The Accelerating Universe	<i>Measuring Eternity</i> , Ch. 15; Pasachoff & Filippenko: <i>Cosmology</i> , p. 377-388
Apr 29	Course Wrap-Up	Davies: <i>That Mysterious Flow</i> ; Musser: <i>A Hole in the Heart of Physics</i>

**MIDTERMS:** Exam #1: February 10 and 11  
Exam #2: March 24 and 24  
Exam #3: April 28 and 29

**FINAL:** Tuesday, Dec 9, 9:30-11:30  
Presentation of course projects!

calvin + hobbes

I GUESS IF WE GET TO HAVE SNACKS, IT WOULD BE OK TO TIME TRAVEL. IF THEY'RE GOOD SNACKS, I MEAN.

GREAT! PUT ON YOUR VORTEX GOGGLES.



THE DIAL IS SET FOR 140 MILLION YEARS AGO, SO  
**OFF WE GO-O-O!**



I HAVE A QUESTION. WHY DON'T WE GET YOUNGER AS WE GO BACK IN TIME, AND DISAPPEAR AS WE PASS THE DAY WE WERE BORN?



I'D EXPLAIN IT, BUT THERE'S A LOT OF MATH.

I THOUGHT YOU GOT A "D" IN MATH.

