Class Meeting: **T** & **Th** 10:10-11:30 in Heg 106
Lab Meeting: **W** 1-3 in Heg 107

Office Hours: **TBD**

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Time Examined: Its Physical Nature and Measurement

Course Description — St. Augustine famously proclaimed "What, then, is time? If no one asks of me, I know; if I wish to explain to him who asks, I know not." 1500 years later, Einstein revolutionized physics by recognizing that time is malleable: he showed that simultaneity depends on how you are moving, and that clocks in motion or acted on by gravity measure time differently. In this course we will take up a detailed examination of the evolving physical description of the nature of time, which can seem to clash with our common sense perception of time. We will examine the physics that helps us pursue conceptual clarity on this and several other foundational aspects of the nature of time. This will entail a focus on the measurement of time and a detailed study of clocks. Throughout we will test our ideas about time and clocks through laboratory experiments.

As this is a new and not fully formed course, we are expecting that you will be co-creators of its content and trajectory. We hope that you will consistently offer us input about topics you would like cover or go more deeply into. Of course, we will be consistently emphasizing quantifiable questions rather than purely speculative lines of thought.

Course Goals:

- We would like to build up our physical notion of time and deconstruct our common-sense notion of time. Both of these come down to forming clear ideas about the physical measurement of time.
- Self reflection about how you think about time and knowing how you arrive at those beliefs.
- A level of comfort with quantitative arguments about time and its different scales.

Course website: faculty.bard.edu/~hhaggard/teaching/phys125Sp19/

Homework Schedule — Short homework assignments will be due in class on Tuesday and Thursday. This should allow the homework to be manageable each time. Lab write-ups will be due Mondays at noon in Hegeman 107.

Grading Structure	
Homework	25%
Labs	15%
Exam 1	20%
Exam 2	20%
Exam 3	20%

Lateness and Other Anomalies — Late work will be accepted before we have graded the assignment with a 20% deduction on the graded score. After work has been graded we will no longer accept late work. If you tell us about something ahead of time, almost any situation can be accommodated.

Course Texts: (1) *From Sundials to Atomic Clocks: Understanding Time and Frequency*, by J. Jespersen and J. Fitz-Randolph (Dover, 1999), (2) *The Order of Time*, C. Rovelli (Penguin, 2018). We will also be referring to philosophers and psychologist that have grappled with time.

Week	Topics	Lab
1/28	Subdivision of time and loss of now	Heart Rate Pendulum
2/4	Periodic motion and time dilation	Careful Pendulum
2/11	Oscillator law and loss of universality	Springs & Comparing Clocks
2/18	Electromagnetism and ambiguities in direction	Big L and Big C Circuit analogs
2/25	Synthesis and quantization & time	Exam 1
3/4	Counting, statistics, and clocks	Build LC Circuit Oscillator
3/11	Precision and stability of clocks	Counting Circuit
3/18	**Spring Break**	**No Lab**
3/25	Quantifying the stability of clocks	M & M Lab
4/1	The Allan variance and stability of clocks	Exam 2
4/8	Ensembles of clocks	Quantifying Stability I
4/15	Cosmological implications of physical time	Quantifying Stability II
4/22	Physical basis of the direction of time	Radioactive Decay & Lifetimes
4/29	(**Advising days 4/29 & 4/30**) Cosmic rays	Cosmic Ray Lab
5/6	Implications for the perception of time	Perception of Time
5/13	*Completion days begin 5/15*	Final Exam
5/20	*5/21 last day of classes*	

Note: We reserve the right to adjust this syllabus during the semester

Further recommended books: Our class texts are all you will need for this course, but if you would like to explore these topics in more depth here are some other books we recommend.

A Brief History of Time, by S. Hawking
A classic study that addresses many of the questions we will cover in the class.

The End of Time, by J. Barbour
An excellent introduction to relationalism and time without universal clocks. The second half on quantum time is a harder read.

Why Time Flies, by A. Burdick. A fairly comprehensive coverage of our experience of time.

In Search of Time, D. Falk
A wide ranging treatment of the physics, philosophy and psychology of time.

Time Travel, J. Gleick. An engaging account of the cultural evolution of our notions of time.

It's About Time, D. Mermin
A good non-technical treatment of special relativity and its implications for time.