Tuesday and Thursday
11:00 – 12:15 p.m.
Dr. Burton Budick
Meyer 122
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Office hours: By appointment

A photograph of Einstein taken in 1912.

"The distinction between past, present, and future is only an illusion, even if a stubborn one." – Albert Einstein

"What I'm really interested in is whether God could have made the world in a different way; that is, whether the necessity of logical simplicity leaves any freedom at all." – Albert Einstein

"There is no better illustration of the unpredictable payback of fundamental science than the story of Albert Einstein and the Global Positioning System… the next time your plane approaches an airport in bad weather, and you just happen to be wondering "what good is basic science," think about Einstein and the GPS tracker in the cockpit, guiding you to a safe landing." – Clifford Will

The laws of physics are the same regardless of your motion. That's the theory of relativity. Though the statement of the relativity principle is simple, the implications of it will challenge your notions of space, time, energy, mass and gravity. This course is a historical presentation of relativity including its applications to astrophysics and cosmology. Some of the topics we will study are:

- Our place in the Universe
- Geocentric or heliocentric solar system
- The roots of special relativity in electromagnetism
- My now is not your now: the relativity of simultaneity
- Time and space intervals are relative
- What's not relative about relativity
- $E=mc^2$
- General relativity
- Expansion of the Universe
- Cosmology: the Big Bang
- The size and shape of the Universe
- The future of the Universe
- Dark matter and Dark Energy
- Quantum Mechanics
- Quantum Weirdness
- Uncertainty Principle

Course texts

1. *Simply Einstein: Relativity Demystified* by Richard Wolfson, W.W. Norton and Co. This recently published volume gives a historical development of relativity before Einstein and sets the stage for Einstein's work and his special and general theories of relativity, along with the famous $E = mc^2$ formula.
2. *Big Bang* by Simon Singh, HarperCollins. Singh captures the excitement of both ancient and current cosmologies. The personalities of the scientists who have contributed to the Big Bang, as well as their efforts and insights, make for fascinating learning.
3. *Mr. Tompkins in Paperback* Gamow
4. *In Search of Schrodinger's Cat* Gribbin
5. *Six easy Pieces* R. P. Feynmann
6. *Lecture Notes for 20th Century Concepts in Space, time and Matter* Tycho Slater This document is an essential resource for this course. It contains the notes (sometimes very detailed) for all the lectures and additional reading material, which you may find very helpful.

Purpose of this Course

This course is intended as an introduction to the concepts in physics. The emphasis of this course will not be on equations, but rather on the concepts of physics.
You will, however, be required to manipulate some simple equations.
It is important that you are comfortable with elementary algebra and geometry (see handout titled "Mathematical Background"on page 9). The first homework will review these concepts. Some knowledge of trigonometric functions would also be helpful, but will be taught in the course as needed.
The major goal of this course is to leave you with a sense that a general knowledge of physics can be gained without any advanced mathematical background, and to encourage you to comtinue to broaden your scientific knowledge.
I welcome your suggestions for ways in which the course may be improved.

Your Responsibilities

- **Lectures:**It is important that you attend the lectures. Since we will not be following any particular book very closely, there may be material presented in lecture that is not found in any of the assigned texts. Lectures are on Tuesdays and Thursdays from 11:00 to 12:15 in room 122.

- **Reading:** Also, it is important that you do the assigned **reading before coming to lecture.** You are encouraged to ask questions about the reading during the lecture**. Also, read all the handouts.**

- **Homework Problems:** Assignments will be made each week and posted on NYUClasses. Your solutions are to be handed in at the beginning of lecture on the date due. Late problems will not be accepted.
  Solutions to the HW will also be posted.

- **Exams:** There will be 2 in class exams and a final exam. The dates for the 2 midterms are listed below in the syllabus. The date of the final will be posted as soon as it is known.
  Do not buy plane tickets before the date of the final is announced. I will post practice exams before each of the exam dates.

- **Questions:** Ask questions. If there is anything you don't understand, ask. If you are completely lost let me know as soon as possible(either during lecture , or soon afterward). It is very important not to fall behind in this course, as later lectures depend on the material covered in earlier lectures.
  I hope that the class atmosphere is relaxed enough to permit you to ask questions when you don't understand what has been said or if some foreign term has been used.

<u>Grades</u>: Course grades will be based on the two in-class exams, the final exam, the assigned problems and quizzes. The relative weighting is

First midterm exam	20%
Second midterm exam	20%
Final exam	40%
Homework	20%

I am available to answer questions about the lectures, homework, any aspect of the course, any aspect of physics, or anything else. You can reach me as follows:

Burton Budick

Office hours: TBA

E-mail: bb2@nyu.edu

You can access announcements, assignments, and other documents on BrightspacR
This will be our primary method of communication.

<u>Weekly Schedule of Topics, Readings</u>

Note: Homework problems will be assigned in lecture each week.

Date	***Lecture Topic***	***Reading***	***Lecture#***
R Sep 2	Overview and some history, Geocentric theories of the solar system	S 1 W 1, 2	1
R Sep 9	Position, velocity, acceleration, vectors Heliocentric theories of the solar system	S 1, 2 W 3	2
T Sep 14	Newton's Laws, Gravity, Kepler's Laws	W3 S 1, 2	3
T Sep 21	Wave motion and interference, speed of light The wavelength of visible light	W 4, F 5, S2	4
R Sep 23	Electric and Magnetic fields, Coulomb's Law	W 5	5
T Sep 28	The Electromagnetic Spectrum, speed of light	W 4, 5, S 3	6
R Sep 30	Michelson-Morley experiment	W pages 68-77 S pages 94-98	7
T Oct 5	Simultaneity, clocks	W 7	8
R Oct 7	Postulates of relativity, Time-dilation, Length contraction	W 96-106	9
R Oct 14	Lorentz transformation, space-time intervals	W 107-122, 139-148	10
T Oct 19	***EXAM I***		
R Oct 21	Addition of velocities	W 151-154	11
T Oct 26	Past, Present,and Future; meaning of "$E=mc^2$"	W 164-173	12
R Oct 28	Distance scales, parallax, The Great Debate, Cepheids	S 167-203, 207-214	13
T Nov 2	Gravity and geometry, Einstein field equations, Tests of General Relativity	W 204-211, 174-190, S 124-144	14
R Nov 4	Photoelectric effect and the photon, Structure of the atom, Black body radiation	S 230-249, G33-61	15
T Nov 9	Hubble's Law, The Cosmological Principle	S 214-229	16
R Nov 11	Radioactive Decay, Nucleosynthesis, The curve of binding energy	S 3, S 7	17
T Nov 16	Beta decay, neutrinos, Curve of Binding Energy, fusion		18
R Nov 18	Structure of the universe, Big Bang cosmology I. Cosmic Microwave Background (CMB), Hubble constant	S 330-336, 372-384, W 154-159	19
T Nov 23	Big Bang Cosmology II	handout	20
R Nov 25	***No Class***		
T Nov 30	Waves and particles, Two slit Gedanken experiment	F 6, G128-134	21
R Dec 2	Schroedinger equation, meaning of the wave function	G112-118	22
T Dec 7	Measurement in quantum mechanics, Indefiteness and uncertainty	F 6, G 8	23
R Dec 9	Reality in quantum mechanics, Einstein, Rosen, Podolsky paradox	W 12, F 6	24
RY Dec 14	Dark Matter and Dark Energy	W 16	25