

01:750:106: Concepts of Physics for Humanities and Social Science Students
Spring 2013: MTh 11:30 AM – 12:50 PM, Van Dyck 211 (CAC)
Final Exam: Thursday, May 9, 8:00 - 11:00 AM



Brief course description: During your lifetime, our society will confront a host of scientifically and socially important issues including energy policy, climate change, space exploration, biomedical innovations, and public health. In addition, research in basic science will continue to reveal the inner workings of nature and spur incredible technological innovations.

In this course, you will build a foundation of knowledge that will help you to navigate these issues of the future. This course will be organized around a set of four basic questions that underlie a large portion of modern physics research. You will learn about concepts of sustainable energy, astronomy, physics at small scales, and emergent phenomena (details are on the next page). We will place a strong emphasis on how to use scientific reasoning and quantitative models to reach evidence-based conclusions, and on applying physics to questions that have an impact on our lives.

Prerequisites: We will assume you are familiar with arithmetic and basic algebra.

Audience: Our emphasis will be on essential science knowledge for citizenship, and not the technical knowledge required for science professionals. Although many of our discussions will be at a qualitative level, we will often work with equations, and learn how to build and apply quantitative models of physics. It is therefore important for your success in this course that you are familiar with basic algebra.

Course Objectives: There are three main goals for this course:

- To cultivate an interest in physics and science in general, and to value physics as an essential aspect of our society.
- To develop basic skills in scientific reasoning, specifically building and testing scientific models, and understanding the strengths and limitations of these models.
- To build knowledge of some of the basic principles and big ideas in physics.

This course qualifies for core curriculum requirements in the natural sciences.

Instructors and Office Hours: There are five instructors in this course: Prof. Saurabh Jha, Aatish Bhatia, Deepak Iyer, Simon Knapen, and Michael Manhart. You can contact all of them at phy106@physics.rutgers.edu. Office hours are as follows:

Aatish Bhatia, Deepak Iyer, Simon Knapen, Michael Manhart	Monday 2-3 PM	Kreeger Learning Center 117 (CAC)
Prof. Saurabh Jha	Wednesday 3:30-4:30 PM	Serin 315 (Busch)
Online office hours	Wednesday 9-10 PM	Sakai chat on course website

Instructors will also be available for questions and discussions immediately after each class. We strongly encourage students to attend office hours for help on course content, homework, projects, exam preparation, and any other aspect of the course. Instructors are also available by appointment for students who cannot attend the regular office hours.

Textbook: No textbook is required. All reading materials and other resources will be posted on Sakai. iClickers are required. Here are some suggested supplementary textbooks:

- Lindenfeld P, Brahmia SW. (2011) *Physics: The First Science*. Rutgers University Press: Piscataway.
- Muller R. (2008) *Physics for Future Presidents: The Science Behind the Headlines*. Norton: New York.

Course Outline:

- Introduction (Saurabh Jha) 1 day
- Module 1: Can we meet our energy needs with renewable sources? (Aatish Bhatia) 6 days
 - *The world’s oil supply is shrinking, but our energy needs are rising. Whatever our motivations, we’ll soon have to ask the question: how can we meet our needs without fossil fuels? In this module, we’ll see how physics can be used to address this real world question. We’ll develop a quantitative understanding of energy and use it to model our energy consumption and production. The focus will be on using quantitative estimates and an understanding of physics to build an energy plan that adds up.*
- Module 2: What are the smallest building blocks of nature? (Simon Knapen) 6 days
 - *In our journey towards the current understanding of the smallest components of nature, we will explore the counter-intuitive world of quantum mechanics and investigate the impact of $E = mc^2$ on our society. We will do so by studying important examples as the atomic bomb and the Fukushima disaster and will learn to distinguish between different types of radioactivity and the risks associated with them.*
- Midterm Exam 1 day
- Module 3: “What is our place in the cosmic perspective?” ^a (Deepak Iyer) 6 days
 - *In this module, we’ll learn about the origins of the universe. We’ll delve into far-away worlds using tools that the ancient philosophers and astronomers built, and learn how they observed, measured, and understood celestial phenomena. We’ll study where matter comes from, and along the way, encounter interesting physical phenomena and understand the nature of light. We’ll get a glimpse of what cutting edge astronomy and cosmology is grappling with today. We’ll even get down and dirty and become amateur astronomers for a day, and perhaps spend an evening gazing at the beautiful winter skies.*
- Module 4: How does complexity emerge from simplicity? (Michael Manhart) 6 days
 - *The same basic physical laws give rise to everything ranging from boiling water to the emergence of life, and yet it seems inconceivable that these complex phenomena could be predicted from those simple laws. In this final module, we will explore a radically different perspective on how such incredible complexity emerges from simplicity, which drives the application of physics to fields ranging from biology to social networks.*
- Concluding remarks (Saurabh Jha) 1 day
- Final Exam 1 day

^aQuote taken from the fascinating series *Cosmos* by Carl Sagan.

Class structure: Most classes will include a combination of traditional lecturing, iClicker questions, videos and multimedia, and some short activities. In addition, each module will contain one or two in-class workshops, where students will explore a specific topic in small groups. For some of these workshops you will need to bring a laptop, so please come prepared! If this will be a problem for you, please let us know in advance. You will be responsible for handing in a workshop assignment that will count towards the final grade.

Homework: There will be reading assigned for each class to complement the material in lecture. We will assess reading comprehension during class using iClicker questions. There will also be homework to submit for Modules 1 and 3.

Blog Projects: An important aspect of this class is to critically read popular science writing and carefully analyze the consequences of a line of reasoning. To this end, there will be two written projects in the form of online blog posts on Sakai. Students will choose a topic that complements the material being covered in class.

You will be able to choose from a list of popular science articles, supplemented with a list of questions, as a springboard for further research. You will be expected to find at least two additional resources and to develop a thoroughly reasoned and well-written summary of a research topic. You should write at a level appropriate to explain your research topic to your classmates.

There will be two blog posts due. You must submit a draft two weeks prior to the final submission. Peer review is an important part of the scientific process, and you will be asked to review and provide constructive criticism on the arguments and research presented in the draft post of your peers. You will be graded on your draft, your final writeup, and the quality of feedback you provide to your peers.

Exams: There will be a midterm exam and a final exam. The midterm exam will cover material from Modules 1 and 2. The final exam will be cumulative, with approximately a third of the questions on Modules 1 and 2 and the remaining two thirds of the questions on Modules 3 and 4. Bring a calculator and your Rutgers student ID.

There will be make-up exams for those who have an excused absence. If you are unable to attend the exam due to a class conflict, illness, or some other serious and unforeseen event, you must provide documentation to your instructor immediately to take the make-up exam.

Grading scheme	Grade distribution
5% – iClicker questions in class	85% -100% A
10% – Workshop participation	80% - 85% B+
10% – Homework	70% - 80% B
30% – Projects	65% - 70% C+
15% – Midterm exam	50% - 65% C
30% – Final exam	40% - 50% D
	0% - 40% F

Important Dates:

Homework 1 due	Thursday, February 14
Blog 1 draft due	Monday, February 25
Blog 1 final due	Monday, March 11
Midterm exam	Thursday, March 14
Homework 2 due	Thursday, April 11
Blog 2 draft due	Monday, April 22
Blog 2 final due	Monday, May 6
Final exam	Thursday, May 9, 8:00 - 11:00 AM

Attendance Policy: In-class activities (workshops and iClicker questions) constitute 15% of the course credit. If you will not be able to attend a workshop for a valid reason, you should immediately notify the instructors. If you will not be able to attend class for an extensive period of time (for example, for medical reasons), you must notify one of the instructors as soon as you become aware of the situation.

In-class conduct: When attending class you are expected to be attentive and to engage in discussion when prompted. As a consideration to your classmates, we request that students not use electronic devices except when needed for the class.

Academic Integrity: As a Rutgers University student, you have agreed to abide by the University’s academic integrity policy, the Code of Student Conduct. Cheating prevents you from making progress, is unfair towards your peers and can seriously jeopardize your studies at Rutgers. Also, it just isn’t cool. More information on Rutgers’s policies can be found at <http://academicintegrity.rutgers.edu/>. Lack of knowledge of the academic integrity policy is not a reasonable explanation for a violation.

Students with disabilities: If you have a disability, you must to speak to us early in the semester to make the necessary arrangements to support a successful learning experience. You can find more information on Rutgers disability services at <http://disabilityservices.rutgers.edu/>.

Physics education research project: You will be asked to participate in a research project intended to evaluate and improve the educational techniques used in the course. Participation is entirely voluntary. Whether or not you choose to participate will not affect your grade.

Detailed Schedule:

Date	Instructor	Topic	Assignments
Th 1/24	Prof. Jha	Introduction	
M 1/28 Th 1/31 M 2/4 Th 2/7 M 2/11 Th 2/14	Aatish Bhatia	Conservation of Energy Explore: Workshop on Conservation of Energy Energy in our lives, the Energy Crisis How much Energy do we use on Transport Adding up Renewable Energy Tallying up our Energy Budget	HW1 assigned HW1 due
M 2/18 Th 2/21 M 2/25 Th 2/28 M 3/4 Th 3/7	Simon Knapen	Introduction to Quantum Physics Quantum Mechanics and Probability The Manhattan Project and the Atomic Bomb Workshop: Radioactivity Nuclear Power and the Fukushima Disaster Introduction to Modern Particle Physics	Blog 1 draft due Blog 1 peer review
M 3/11 Th 3/14		Midterm Review Midterm Exam	Blog 1 due
M 3/18 Th 3/21		SPRING BREAK SPRING BREAK	
M 3/25 Th 3/28 M 4/1 Th 4/4 M 4/8 Th 4/11	Deepak Iyer	Understanding Scales and Distance, and early astronomy Gravity, Orbits, Stars, Galaxies Light and Observing the night sky Workshop - How old is the universe? Origins of the universe Black holes, exoplanets, recent developments	HW2 assigned HW2 due
M 4/15 Th 4/18 M 4/22 Th 4/25 M 4/29 Th 5/2	Michael Manhart	Introduction to Emergence Thermodynamics and Statistical Physics Workshop: The Game of Life Emergence in Real Materials – Superconductors Emergence in Living Matter – Proteins, DNA, and Life Workshop: FoldIt	Blog 2 draft due Blog 2 peer review
M 5/6 Th 5/9	Prof. Jha	Conclusion and Final Review Final Exam	Blog 2 due