Physics 100 – Physics of the natural world
Spring term 2007, University of Rochester
Information, Syllabus, and Schedule

This is an introductory course designed especially for students in the humanities and other non-scientific fields who are interested in learning something about the physical world. Topics include the scale of the universe from galaxies to atoms and quarks, the fundamental forces of nature, motion and relativity, energy, electromagnetism and its everyday applications, the structure of matter, atoms, light and quantum mechanics. There are no prerequisites, no background knowledge is required and the material will be presented with very little mathematics. Substantial use will be made of demonstrations.

Course instructor:

Prof. Steven Manly e-mail: **Steven.Manly@rochester.edu**
Phone: 275-8473
Office: B+L 203E

Office hours: **Monday 12:30-1:45 pm or 3:15-4:00 pm *or by appointment.***
With my travel and your variable needs/schedules, I find that fixed office hours are not terribly practical. If I am out of town or if the Monday time slots do not work for you, speak to me or send e-mail to find a mutually suitable time.

Course web site:

Extensive use will be made of the web for distributing course materials, making announcements, etc. The class URL is
http://www.pas.rochester.edu/~manly/class/P100_2007/ **.**
If you have difficulty reaching this site (and you've verified it is not your problem), please contact me.

WebCT:

I will report grades at the end of the semester to you via WebCT. You can log into, and learn more about, WebCT at http://webct.rochester.edu . Unless I tell you otherwise, it is unlikely that you will find anything in WebCT concerning this course until the time that I report final grades to you.

Course e-mail:

I will set up a course e-mail distribution list. Time-critical announcements, exam location changes, etc. will be sent to you via e-mail. ***It is essential that you be on this list if you are in the course.***

Lectures:

Hoyt Auditorium, Monday and Wednesday from 2-3:15 pm

Textbook:

- Art Hobson, **Physics Concepts and Connections**, 4th edition (2007), Pearson Prentice Hall.
- Expect additional reading to be added as we go. I hope to make these available online or as handouts.

Philosophy and goals:

I'm very excited to be teaching Physics 100. This course is meant to be fun and interesting. There really is nothing as wacky as reality and it will be my pleasure to take you on a guided tour. This is a conceptual course. The use of mathematics will be limited. We'll delve into the structure of matter, the nature of forces, the life cycles of stars and the evolution of the universe. We will explore how the very small and the very large in this universe are intimately related.

My main goal for this class is to expose you to the modern scientific view of the universe. I hope to do this in a way that you will find exciting and not intimidating. This class will help you understand the nature of science, from the basic scientific method and process of discovery to the reality of scientific politics. It is my hope that this experience will help you appreciate the degree to which science (and physics in particular) shapes the life you live.

I'm not one to require that you come to class. In this case, however, I want to warn you that the topics covered in this course consist of the things that I do for a living. In many parts of this class, I will not be basing my lectures from the textbook reading. The topics covered in the reading assignments will be similar to those covered during lecture, but in many sections of the course I will be giving you my own take on the subject. I will post what I write during lecture online, often with some degree of fleshing out with what was said during class. But - be warned - I think the online notes will often be a poor substitute for the discussions/lecture we have during class.

I hope that you will be willing to ask questions and participate in discussions during lecture. Again, this is not required, but it will lead to a vastly improved experience for us all if you participate.

Recitations and problem sets:

Each week you will meet for up to two hours in what we'll call a "recitation" section with an undergraduate or graduate teaching assistant. I consider this an integral part of the course. I will script out a series of exercises and discussions for you to participate in during this time. We will try to accomplish a few different things in these recitations. First, this will be a place for you to check that you understand the basic ideas discussed in class during the previous week. It's a place to get some of your questions ironed out in an environment that is a bit more intimate than the lecture hall. Second, you will work through selected analytical problems together. (I don't intend to turn this into a math-intense physics course … it's just that doing simple analytical problems is a good path to a deeper conceptual understanding for many students.) Finally, I plan to have you do some hands-on or visual exercises to reinforce some

of the physical concepts. Material and concepts covered in recitation is considered fair game for the exams. Solution sets for the problems done in recitation will not be released.

We will have something like 11 or 12 recitations this semester. My intent is to make them a valuable part of the course. Because I hope to work on some of the goals of the course in recitation, I would like you to attend recitation. To encourage this, I will allocate 8% of your final grade to recitation attendance/participation. You will get 1 of the 8 percentage points for each recitation that you attend and participate in, up to 8. I encourage you to attend all recitations, but I will only count up to 8 of them in your grade. This scheme allows you to miss 3 recitations, no questions asked, without penalty.

Each week, I will assign a few analytical and conceptual problems for you to do outside of lecture and recitation (problem sets). These questions will help you focus on essential points and will give you a sense of the kinds of things I might ask on exams. Working on these problems after reading over the appropriate sections in Hobson (or other reading) will be the best way to prepare for recitation each week. Solutions to these problems will be released one week after the assignment is given out. For now, I do not plan to take up and grade these problem sets. I reserve the right to require that you hand them in for credit if I feel it is needed to keep the class on track.

Student-led presentations/discussions:

The class will be divided into groups of six students. Each group of six students will select a topic from a supplied list and "teach" it to the class during a half-hour time slot toward the end of the semester. Each group can teach the topic using whatever format they feel works well. You can make use of written, video and audio sources, teach using conventional chalk on the board, PowerPoint, video, play, song, lecture, posters, etc. Whatever floats your boat. You can petition me to do a different topic.

I have allocated 5 class periods for groups to make presentations. Each student will grade the effort of each of the groups. Each student will give me a measure of effort supplied by each member of their group.

To encourage participation in the grading process, 4% of your comes from attending and grading presentations. You will get 1% for each presentation day attended/graded, up to 4%. This allows for 1 day missed with no penalty.

I'll give you more information on the presentations soon.

Makeups/missing exams and problem sets:

I will evaluate your grade using four separate algorithms shown below. If you are present for each exam, this scheme will end up dropping your worst grade. If you miss an exam, that missed grade will count as your drop. I will not give makeup exams in this course. If you miss two exams, contact me … preferably before you miss the second exam if you know about it in advance.

Grades:

- All exam grades will be rescaled so that the class mean of each exam is 75. For example, if the overall mean of exam 1 is 63, everyone's exam 1 grade will be rescaled by 75/63 before the grade calculations below are performed. This renormalization will (approximately) even out the variations in exam difficulty.
- Your grade will be calculated via one of the five schemes shown in the table below, taking the one that yields the highest numerical average. The numbers represent the relative contribution of the item in that column to your final numerical grade.

Scheme	Exam 1	Exam 2	Final exam	Present.	recitation	Present. grading
1	---	29.33%	29.33%	29.33%	8%	4%
2	29.33%	---	29.33%	29.33%	8%	4%
3	29.33%	29.33%	---	29.33%	8%	4%
5	22%	22%	22%	22%	8%	4%

- Your initial relative position on the grading curve depends solely on the numerical grade as calculated above. I will then assign letter grades to the numerical scale.

Finally, if something is fundamentally not working well in this course, I reserve the right to make changes in the scheme outlined in this syllabus in order to improve things. I would do that with great reluctance and only after discussing it with you.

Schedule:

This course syllabus is tentative. I may adjust the speed and/or topics a bit after I get to know you and your interests better. Other reading will be added as we go, particularly in areas where Hobson is weak. The exam dates are fixed. Exam subject matter will change as appropriate for the material covered.

Wednesday, January 17, 2007 –

Course introduction

How to bore your friends – the nature of science

Scientific notation, scales in our universe, the intimate relationship between the small and large, how science differs from other human endeavors, scientific method, scientific truth, units, errors

Reading in Hobson – Chapter 1 (p. 2-25) and section 2.4 (p. 37-38)

Monday, January 22, 2007 –

Space, time and pantyliners

Nature of space and time, coordinates, dimensions, speed, speed of light, Michelson-Morely experiment, Special Theory of Relativity, length contraction, time dilation

Reading in Hobson – Section 3.4 (p. 59-60), Sections 10.1-10.6 (p. 220-235)

Wednesday, January 24, 2007 –

The relative nature of mass and energy

More on Special Relativity, spacetime, mass, force, energy, work, energy-mass equivalence

Reading in Hobson – Sections 4.1-4.2 (p. 70-75), Sections 6.1-6.6 (p. 116-127), Sections 10.7-10.8 (p. 235-242)

Monday, January 29, 2007 –

Newton's universe

Newton's laws, the physics of motion, how to predict the future, momentum and energy conservation

Reading in Hobson – Chapters 3 and 4 (p. 52-84)

Wednesday, January 31, 2007 –

Nature's onion and the electric personality of atoms

Atoms, electrons, Brownian motion, Rutherford's scattering experiments, electromagnetism (Coulomb's law)

Reading in Hobson – Chapter 2 (p.29-46), Sections 8.4-8.7 (p. 171-180)

Monday, February 5, 2007 –

A smorgasbord of waves

Electric and magnetic fields, currents, Maxwell's equations, waves, light

Reading in Hobson – Section 8.8 (p. 181-184), Section 9.1 (p. 190-194)

Wednesday, February 7, 2007 –
Light, waves and … what's this particle crap?
Nature of electromagnetic radiation, refraction, diffraction, reflection, wave medium, blackbody radiation, photoelectric effect
Reading in Hobson – Sections 8.1-8.3 (p. 162-171), sections 9.2-9.4 (p. 195-200)

Monday, February 12, 2007 –
Atoms are Bohring
DeBroglie's hypothesis and the wave nature of matter, circular motion, interference, standing waves, Bohr atom, spectra
Reading from Hobson - Chapter 13 (p. 298-316)

Wednesday, February 14, 2007 –
Atoms aren't Bohring after all
Rise of quantum mechanics, Schroedinger's equation, simultaneous advances in science, quantum mechanical model of the atom, periodic table of the elements, chemistry, chemical bonds, molecules
Reading from Hobson – Sections 14.6-14.7 (p. 338-347), expect other reading here

Monday, February 19, 2007 –
Uncertainty is certain
Probability and predictability in the quantum world, Heisenberg's Uncertainty Principle
Reading from Hobson – Sections 14.1-14.5 (p. 320-338)

Wednesday, February 21, 2007 – Exam 1 (during regular class time)
Exact material covered on exam will be announced as the time approaches.

Monday, February 26, 2007 –
Marvels of layer 2
A few wonders of the modern world like x-rays, lasers, superconductors
No reading in Hobson, expect other reading here

Wednesday, February 28, 2007 –
Auto mechanics 101 - there is no free lunch
Thermodynamics, why you don't get something for nothing
Readings in Hobson – Section 6.7 (p. 127-129), chapter 7 (p. 135-156)

Monday, March 5, 2007 –
The nuclear copycat
The structure of the atomic nucleus, protons, neutrons, strong nuclear force, half-life, radioactivity, dangers of radioactivity, uses of radioactivity, carbon-14 dating, nuclear medicine
Reading from Hobson – Chapter 15 (p. 354-376)

Wednesday, March 7, 2007 –
The impact of a strong force
Nuclear fission, nuclear fusion, nuclear bombs, nuclear power, nuclear terror
Reading from Hobson – Chapter 16 (p.380-404)

Monday, March 12, 2007 – Spring Break

Wednesday, March 14, 2007 – Spring Break

Monday, March 19, 2007 –
Gravitation and stellar ideas
Newton's law of gravity, planetary motion, the General Theory of Relativity, the nature of stars
Reading from Hobson – Sections 5.1-5.3 (p. 90-102), section 11.1 (p. 248-254), review sections 16.1-16.4 (p. 380-387)

Wednesday, March 21, 2007 –
Virtual reality: size really does matter
Implications of Heisenberg's Uncertainty Principle, virtual particles, quantum fields and forces, nothing is everything, accelerators and cosmic rays, modern Rutherford scattering experiments
Reading from Hobson – Sections 18.1-18.3 (p. 439-449)

Monday, March 26, 2007 –
From c to Z: the new paradigm
The standard model of particle physics, quarks, leptons, neutrinos, gauge bosons, antimatter, the electroweak force, QCD, Higgs boson
Reading from Hobson – Sections 18.4-18.5 (p. 449-459)

Wednesday, March 28, 2007 –
The gravity of the situation leads to a stellar life
Stellar evolution, main sequence, white dwarfs, red giants, pulsars, black holes, supernovae, synthesis of elements
Reading from Hobson – Sections 5.4-5.6 (p. 102-110)

Monday, April 2, 2007 –
The expanding universe: more like a butt than a zit
The expanding universe, Hubble, cosmic microwave background, fluctuations in the CMB, the Big Bang, inflation, phase transitions in the early universe, elemental ratios, the future of the universe
Reading from Hobson – Sections 11.2-11.7 (p. 254-268)

Wednesday, April 4, 2007 –
The dark side
Evidence for dark matter and dark energy, possible nature of these beasts
Expect reading outside of Hobson

Monday, April 9, 2007 – Exam 2 (during regular class time)
Exact material covered on exam will be announced as the time approaches.

Wednesday, April 11, 2007 – Student presentations – topics TBA

Monday, April 16, 2007 – Student presentations – topics TBA

Wednesday, April 18, 2007 – Student presentations – topics TBA

Monday, April 23, 2007 – Student presentations – topics TBA

Wednesday, April 25, 2007 – Student presentations – topics TBA

Monday, April 30, 2007 –
Beyond the Standard Model
Possibilities for what lies underneath the Standard Model, supersymmetry, string theory
Expect reading outside of Hobson

Wednesday, May 2, 2007 –
What's around the next curve in the road?
The Large Hadron Collider (LHC), neutrino mass, the International Linear Collider (ILC), matter/anti-matter asymmetry, Relativistic Heavy Ion Collider (RHIC), dark matter searches, SuperNovae Acceleration Probe (SNAP)
Expect reading outside of Hobson

Tuesday, May 8, 2007 – Final Exam starting at 4 pm in location TBA
Cumulative.