Physics 102 – Visions of the Multiverse
Fall term 2009, 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 about science, physics and concepts of a multiple universe reality. Topics include the nature of science, Newton's laws, relativity, light, quantum mechanics, the nature of particles and forces, and cosmology. In the course of surveying the modern scientific view of the universe, a number of serious concepts of a multiuniverse reality will be examined, including the many-worlds view of quantum mechanics, inflationary and string-based cosmologies. 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. This course is intended to be equivalent to our Physics 100 course in terms of satisfying cluster requirements.

Course instructor:

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

Office hours: **Tuesday 2-3 pm and Wednesday 11 am-noon *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 listed time slots do not work for you, speak to me or send e-mail and we will find a mutually suitable time to meet.

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/P102_2009F/ .
If you have difficulty reaching this site (and you've verified it is not your problem), please contact me.

Blackboard:

I will make some use of the Blackboard course management system. In particular I will use that system to email the class, report grades, and distribute material that should not be openly accessible on the web. It is essential that you let me know if you are not receiving emails sent to the class.

Lectures:

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

Textbook:

- Art Hobson, **Physics Concepts and Connections**, 4th edition (2007), Pearson Prentice Hall.
- Hobson's text is a decent text for a conceptual physics survey course. I will assign reading and problems in Hobson when there is overlap between what we are covering and what Hobson covers (mostly in the first half of the course). I will assign readings outside of Hobson as well. Generally these will be posted on BlackBoard and brought to your attention in class and via email.

Philosophy and goals:

Physics 102 is meant to be fun and interesting. There is nothing as wacky as reality and it will be my pleasure to take you on a guided tour of some of the delightfully twisted parts of our universe. This is a conceptual course. The use of mathematics will be limited.

I have three pedagogical goals in this course. When it is over, I hope you have an appreciation of the nature of science, how it works and what are its strengths and shortcomings. Second, I would like to paint for you the modern scientific view of the universe. Finally, I want to explore with you numerous concepts of a multi-universe cosmic reality – mostly arising in modern physics, though we will discuss other ideas. It is my hope that this experience will help you appreciate the depth of the strangeness in our universe and 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 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 a graduate (or undergraduate) 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 and conceptual 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 around 9 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 14% of your final grade to recitation attendance/participation. For each recitation you attend, you will receive 1 percentage point. An additional percentage point will be given to you if you participate in the recitation discussions/calculations as determined by the recitation section leader. I encourage you to attend all recitations, but I will only count up to 7 of them in your grade. This scheme allows you to miss 2 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. There will be a total of ~10 problem sets assigned. You are to turn in your answers to each problem set at the end of class on the date specified on the assignment as posted on the web. We will check each problem set handed in for 'reasonable effort'. Not all problems have to be done and not all problems have to be done correctly to get credit for doing the assignment. Again, 14% of the final grade is allocated to problem sets. For each problem set handed in with 'reasonable effort' put forth, you will receive 2%. We will count up to 7 problem sets in the grade calculation. This gives you the freedom to miss up to 3 problem sets with no grade penalty.

Recitation leader(s):

- TBA

Student reports/articles:

Once the semester is progressing smoothly, the class will be divided into groups of ~5 students. Each group will select a topic from a supplied/suggested list and create a written report/article that will "teach" the topic to the rest of the class. The report could be in the form of a cross between a basic research paper and a magazine article. You should not feel limited by your preconceptions as to what a research paper should look like. Feel free to include figures, web links, links to short video/audio clips, etc. I can post materials on blackboard as needed for each group. The report should be original. It is fair to use work from others so long as proper attribution is given.

The reports will be due on December 7. At that point each student will be asked to read/view each of the other groups' reports and grade them according to criteria given. Students will provide Prof. Manly with those grades as instructed

at the time as well as an evaluation of their own group members' contributions to their report. The class evaluations will be used by me to determine the relative grade ranking of the different groups and assign a numerical grade for the report for each individual. I will act as a safety valve to make sure the grading is appropriate/fair. The internal group participation/effort evaluations may be used to modify individual grades with respect to the group grade.

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

Makeups/missing exams and problem sets:

I will evaluate your grade using three 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 three 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	Reports	Prob. sets	Recitation
1	---	22%	30%	20%	14%	14%
2	22%	---	30%	20%	14%	14%
3	16%	16%	20%	20%	14%	14%

- 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.

Schedule:

This course syllabus is tentative. I may adjust the speed or topics as the course evolves. Reading assignments will be provided later and as we proceed through the term. The exam dates are fixed.

Wednesday, September 2, 2009 – Faith-based multiverse I, Intro to course, multiverse taxonomy
Wednesday, September 9, 2009 – Nature of science, kinematic variables
Monday, September 14, 2009 – Newton's laws
Wednesday, September 16, 2009 – Electrostatics, gravity, fields
Monday, September 21, 2009 – Special relativity
Wednesday, September 23, 2009 – Maxwell's equations, light
Monday, September 28, 2009 – Waves, rise of quantum mechanics
Wednesday, September 30, 2009 – Bohr model, Schrödinger's equation
Wednesday, October 7, 2009 – Quantum mechanics, multi-electron atom, chemistry
Monday, October 12, 2009 – Quantum indeterminacy, many worlds multiverse
Wednesday, October 14, 2009 - Exam 1 – during regular lecture time in Hoyt
Monday, October 19, 2009 – Multiverse of wishful thinking, quantum uncertainty
Wednesday, October 21, 2009 – Nuclear physics
Monday, October 26, 2009 – Nuclear physics, stars
Wednesday, October 28, 2009 – Particle physics and the quantum nature of forces
Monday, November 2, 2009 – The standard model of particles and forces
Wednesday, November 4, 2009 – Anthropic principle
Monday, November 9, 2009 – The place of Earth in the cosmos, gravity, general relativity
Wednesday, November 11, 2009 – Hot big bang cosmology, cyclic big bang multiverse
Monday, November 16, 2009 – Bouncing black hole multiverse, cosmological natural selection, inflation
Wednesday, November 18, 2009 – Inflationary cosmology, beyond-the-horizon multiverse, bubble multiverse
Monday, November 23, 2009 – Exam 2 – during regular lecture time in Hoyt
Monday, November 30, 2009 – Dark matter, dark energy, precision cosmic microwave background measurements, dark matter pseudo-multiverse
Wednesday, December 2, 2009 – String theory, extra dimensions
Monday, December 7, 2009 – String theory, extra-dimensional multiverse, Ekpyrotic multiverse, dark matter pseudo multiverse
Wednesday, December 9, 2009 – Computational multiverse, mathematical universe hypothesis, multiverse taxonomies reprise,
Tuesday, December 16, 2009 – Final exam, 4 pm, location TBA – cumulative