May 2009

Physics 111 – Contemporary Physics for Non-Scientists (4)
Course Outline GE B3

Prerequisites for Phys 111: Passing score on ELM examination, or an ELM exemption or credit in MATH 104. 4 lectures.

Physics 111 provides an overview of the fundamental foundations of modern physics to students not majoring in physics.

Learning Objectives and Criteria:

After completing this course, the student should know...

- What the terms "special relativity", "general relativity", and "quantum mechanics" refer to,
- That time, space, mass, and other physical concepts are relative, depending upon one's state of motion,
- What the equation "$E=mc^2$" means, how it is used, and where it is relevant in our day-to-day world,
- How to think accurately about higher dimensions and "curved" dimensions,
- That gravity is "warped" spacetime,
- What a black hole is,
- How a time machine could in principle be built,
- That the behavior of light, and of particles on the smallest scales is totally unlike our intuitive expectations; and hence that the universe is really very different than most people tend to think,
- What it means for matter and light to be both "wave-like" and "particle-like,"
- Something about the quantum mechanical description of physical reality, including the nature of the wave function, the role of the observer, and the so-called "quantum measurement problem,"
- Something of the history of the development of "modern physics," including names and dates.

Text and References:

Text will be selected at the time the course is offered. Topics will be based on relativity and quantum mechanics.

Content and Method:

Method: Physics 111 is a traditional lecture course (4 Lectures).

Weekly reading assignments will be given. Each class meeting students will be required to submit questions that they have come up with based on the ongoing readings for that week. The questions will then be evaluated, based on their relevance and depth of thought. Students will also be evaluated on their participation in class discussions. Exams will include a single midterm and a comprehensive final exam. Grading will be based on the following approximate percentages: Written questions from the readings - 10 - 20%, Participation in class discussions - 10 - 20%, Midterm examination - 20 - 30%, Final examination - 30 - 40%.

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Content: Physics 111 will adhere to the following topics:

- Weeks 1 - 4: The nature of space and time (relativity)
- Weeks 1 & 2: Einstein's special theory of relativity
- Relative motion
- The relativity of time (time dilation)
- The relativity of space (length contraction)
- The twin paradox
- $E = mc^2$
- Actual examples: particle lifetimes; particle masses
- Time travel
- Weeks 3 & 4: Einstein's general theory of relativity
- What is time?
- Higher dimensions
- Warped space and warped time
- The true nature of gravity
- Gravity and clocks
- Black holes
- Actual examples: the orbit of Mercury; military communications
- Time travel revisited
- The nature of matter and light (quantum mechanics)
- Probability and chance
- The double-slit experiment
- The wave function of quantum mechanics: the ultimate description of physical phenomena
- Implications of the wave function: what is reality?
- Heisenberg's famous uncertainty principle
- Schrodinger's famous cat
- EPR paradox: Einstein's parting shot
- Bell's theorem and non-locality
- Aspect experiments; the recent "two-places-at-one-time" experiment; the Rochester experiments
- Superstrings and other ideas
- Superstring theories
- Quantum gravity