COURSE SYLLABUS:

“MODERN PHYSICS”
Physical discoveries of the past 101 years

Phys 221
Calculation-level investigation of the theories of relativity and quantum mechanics

Course Title: Modern Physics

Web Page: http://www.instruction.greenriver.edu/physics/keith/221

Instructor: Keith Clay
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Office hours: Monday, Tuesday, Thursday 11:00 AM – Noon
Tuesday, Thursday 5:30 PM – 6:30 PM

Class Meetings:
Mon, Tue, Thu SC 117 3:00 PM – 4:00 PM

Prerequisites: The prerequisites for this course are Physics 202 (or 111) and Math 125 or the equivalent. Both are absolutely required. Students should be concurrently enrolled in (or should have previously completed) Phys 203 (or 112) and Math 126 as well. Some material discussed in this course will draw upon elements from Physics 203 and 112, Math 240, and Math 238, but students will be able to pick up the material as it arises.

NOTE: During approximately the fourth week of the term, discussions will turn to light and radiation which will require some understanding of waves. Students studying modern physics who are NOT simultaneously taking Physics 203 or Math 238 should try to learn a little bit about waves, interference, and resonance. An introduction can be found in any good physics text, but an excellent introduction is in Chapter 16 of our textbook (Physics for Scientists and Engineers, by Serway and Jewett).

Assumed Competencies: Students taking this course must have already completed Physics 202 and Math 125 with satisfactory grades. It is assumed that these students will already be able to

- express and utilize basic principles of scientific investigation
- use units and dimensions as a tool for finding solutions and expressing results
- carefully and critically think through a scientific problem
- design an experiment to test a new hypothesis or play with a new idea
- express and utilize scientific ideas in both verbal and mathematical forms
Course Objectives: Since it is assumed that all students taking this course already have substantial scientific reasoning and investigation skills, the objectives for this course are very subject specific:

1. Students should be familiar with all four of Maxwell’s equations and the Lorentz force law, understanding what each of these equations means and how each is used in physical situations.

2. Students should understand relationships between fields and potentials and some devices that rely upon them. Students should associate each of Maxwell’s equations with at least one tool or device.

3. Students completing the course should be able to calculate quantities associated with electric and magnetic fields, although perhaps with “help” as in an “open book, open note” environment.

4. Students should be able to relate the wave equation to Maxwell’s equations, and derive an expression for the speed of light from Maxwell’s equations.

Relationship to Campus-wide objectives:

Green River Community College has identified several educational objectives for all courses and all students on the campus. The objectives of this course include many of these campus-wide objectives which will be directly and indirectly monitored and assessed. These overlapping objectives include enhancement of proficiency in the following areas:

1. Critical thinking and problem solving skills: If there were only one objective to this course it would not be the retention of any fact that is associated with the subject matter called physics. It would be the development of skills needed to analyze any problem carefully, logically, analytically and creatively, with a hopeful eye toward the creation of a viable problem solving strategy.

   Critical thinking and problem solving skills will be assessed using homework assignments, quizzes, laboratory exercises, a class project, and ungraded assessment tests.

2. Mathematical and quantitative reasoning: Successful completion of this course requires the mathematical modeling of many complicated situations, often using models which are not intuitively obvious. Students often comment that physics courses stretch their ability to translate from the real world to mathematical abstractions and back again more than any other.

   Mathematical and quantitative reasoning skills will be assessed using homework assignments, quizzes, laboratory exercises, a class project, and ungraded assessment tests.

3. Clarity of communication and written expression: Verbal exposition is often put to its most stringent test when technical material must be accurately and yet readable described. This course requires written discussion of highly technical subjects and precisely defined concepts, often blending the English language with the language of mathematics.

   Communication and written expression skills will be assessed using homework assignments, quizzes, laboratory exercises, a class project, and ungraded assessment tests.

4. Aesthetic appreciation: The teacher of this class freely pursued the study of physics when a career in engineering or any number of other fields would have been much more lucrative and required less formal education. The reason for this was simply a deep and abiding love for the astounding beauty of the subject matter. Your teacher sincerely hopes that some appreciation of this beauty will rub off on each and all of his students, although aesthetic appreciation will not be directly assessed.

   Aesthetic appreciation of physics will be assessed in part through the work done in preparing and presenting an in-class project of the students choice and design.
TEXTBOOK:

*Physics for Scientists and Engineers, 6th Edition*, by Serway and Jewett. The book will often be referred to as Serway or by the initials of the authors “SJ”. *You will need the chapters on modern physics: Chapters 39 – 46.*

*Mad About Modern Physics*, by Potter and Jargodzki. This is a good book for figuring out some of the questions raised by modern physics. It also includes some answers, but the intent is that you will use this to get yourself asking more and deeper questions.

Thanks to the hard work of your humble instructor, the GRCC library has a large collection of modern physics textbooks that you can check out from the reserve desk. You’ll need to check to see how long you can keep them. These are to be used (and this is a requirement of the course) as supplemental reading material to help you search for answers to the questions that arise during the course.

Some of ADDITIONAL TEXTS are:

- *Modern Physics*, by Bernstein, Fishbane, and Gasiorowicz. This is a very well-written book. It makes for enjoyable reading.
- *Modern Physics*, by Blatt. This is a very streamlined and simplified book. If you are looking for a simple explanation, look here. Available for a few bucks from used bookstores.
- *Modern Physics*, by Harris. You might begin to notice a pattern in the titles of these books. Harris’ book is very recent (© 2008) and thus includes some material missed by the others.
- *Modern Physics*, by Krane. This is perhaps the industry standard. It seems to be used by more universities than the other books.
- *Modern Physics*, by Ohanian. At Ohanian’s insistence this book was reprinted in paperback shortly after publication. Used paperback editions can be found for a couple of dollars.
- *Modern Physics for Scientists and Engineers*, by Taylor, Zafiratos, and Dubson. This is a very complete and well-written book. Maybe tied with Tipler for 2nd place in terms of popularity.
- *Modern Physics for Scientists and Engineers*, by Thornton and Rex. This book gets some good reviews and some not-so-good. Used copies seem readily available.
- *Modern Physics*, by Tipler and Llewellyn. Now in the fifth edition, this one was the industry standard before Krane came along. Still very popular.
- *Principles of Modern Physics*, by Saxena. The word “Principles” does no mean that this is a simplified book. This book is detailed and written at a high level. All of modern physics is here, and strangely enough: most of it is available for free on Google books! Check it out.

Wiki pages:

Throughout this course, students will compile their own “encyclopedia” of the physics of the past 110 years or so. Students will be required to submit three “wiki-articles” per week to the class website. Readings from Mad About Modern Physics are meant to inspire many additional searches, but students are encouraged to draw their inspiration from elsewhere as well. Two of the three weekly wiki-articles must include reading from one of the ADDITIONAL TEXTS listed above (the third may rely on reading from anywhere, including that other Wikipedia). *Students will be asked to present their portions of the encyclopedia to the rest of the class from time to time.*
Laboratory requirements:
As a class we will work though a couple of classic modern physics experiments. We have equipment to measure the photoelectric effect, the Franck-Hertz experiment, and microwave diffraction. Technically there is no “lab credit” associated with this class but these experiments are too important to ignore them completely. Participation in the lab experiments will be counted toward the “lab and wiki” component of the course.

Homework (problem sets):
There will be many homework problems and plenty of discussion questions. Do more if you feel like it. Due to popular demand they will not be graded, and some may be done together in group format during class time. Students are encouraged to suggest topics for homework problems!

Quizzes:
There will be quizzes given throughout the term. Most will be take-home and some may be done in class. Each classroom quiz will contain one long or several short questions, intended to be easily finished in 30 minutes. Take home quizzes may occasionally replace or supplement homework sets.

Exams:
There will be a final exam (take-home or in-class). Since the published final scheduled for this class will most likely conflict with the final scheduled for other courses, the final will not be held during the regularly scheduled time slot published in the schedule. Another time will be announced later.

Attendance:
Due to the small number of class meeting times, missing a class is not a great idea. This course deals with conceptually difficult material, and missing a single discussion can lead to the feeling of being quite lost! The “participation” section of your grade will be influenced by your ability to attend class and contribute to class discussions, especially those related the the History Project. Still, attendance itself will only be collected for the purposes of the college and will not be used for grading.
Late homework, exams, etc.:

Your instructor intends to be relaxed about this. Student homework will be placed in a box with a cat and it will be difficult to tell whether yours is there or not (this is a joke but you aren’t expected to get it yet). *You may turn in your homework a few days late, but please don’t abuse the privilege.* Students should police their own work and prove to themselves that they can keep up in their studies without threats from the teacher. Due to the sequential nature of the material, students will be required to keep up within one week of the class so assignments must be turned in within a week of the due date.

“Guests” in the classroom:

Due to GRCC policy, no one who is not either registered for the class or an employee of GRCC will be allowed in the classroom during lecture or laboratory periods. This includes children, friends, and prospective students. If a guest appears in our class, it is my understanding that the college will send a group of quantum mechanical lawyers who will simultaneously prosecute and defend the offending student until we all go mad.

Grades:

Grades for this class will be computed from the following five components which will be awarded “class points” approximately as follows:

<table>
<thead>
<tr>
<th>Course component</th>
<th>Class points:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiki pages and experiment</td>
<td>25 points</td>
</tr>
<tr>
<td>Homework (roughly 10 problem sets)</td>
<td>25 points</td>
</tr>
<tr>
<td>Quizzes</td>
<td>25 points</td>
</tr>
<tr>
<td>Final Exam (which might or might not include a project)</td>
<td>25 points</td>
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</tbody>
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So how many points do I need to get an A? To pass?

The instructor reserves the right to modify the grading scheme at any time if he believes it is to the benefit of the class as a whole. In general a total of 96 points or more will earn a grade of 4.00, a total of 76 points will earn a grade of 2.00, and the scale is linear ( (points – 56)/10 ).

Other grades:

A grade of “I” will only be given in emergency situations and only if at least 75% of the work is completed satisfactorily. A grade of “P” can only be given if requested in writing at the registrar’s office before the deadline published in the catalog (students should know that completion of a course with a grade of “P” is *not* considered completion of a prerequisite for another class).
Material Covered:

The list of material below is ambitious and subject to change. Although we plan to spend most of the quarter covering just three chapters from Serway and Jewett, the concepts in those chapters are very difficult. More time will be spent on quantization and particle physics if time allows, but some topics may fall by the wayside as well.

Students are encouraged to suggest different directions and different subjects for our study! Some subjects are hard to study without going through the basics (which are essentially outlined below) but attempts will be made to accommodate the modern physics interests of the students.

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject:</th>
<th>SJ Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEEK 1:</td>
<td>Relativity I: meters and seconds again?</td>
<td>39</td>
</tr>
<tr>
<td>WEEK 2:</td>
<td>Relativity II: vectors again??</td>
<td>39</td>
</tr>
<tr>
<td>WEEK 3:</td>
<td>Relativity III: kilograms and dynamics again??</td>
<td>39</td>
</tr>
<tr>
<td>WEEK 4:</td>
<td>What “is” light?</td>
<td>34, 38, 40</td>
</tr>
<tr>
<td>WEEK 5:</td>
<td>Sometimes “waves” act like particles</td>
<td>40</td>
</tr>
<tr>
<td>WEEK 6:</td>
<td>Sometimes “particles” act like waves</td>
<td>40</td>
</tr>
<tr>
<td>WEEK 7:</td>
<td>Uncertainty in the universe</td>
<td>40</td>
</tr>
<tr>
<td>WEEK 8:</td>
<td>Probability and Wave Functions</td>
<td>41</td>
</tr>
<tr>
<td>WEEK 9:</td>
<td>Schrodinger’s Equation</td>
<td>41</td>
</tr>
<tr>
<td>WEEK 10:</td>
<td>Quantization</td>
<td>42</td>
</tr>
<tr>
<td>WEEK 11:</td>
<td>Particle Physics</td>
<td>46</td>
</tr>
</tbody>
</table>

Material may be added or removed from the schedule as time and interest allow.

Special needs:

Any student who needs special accommodations because of a disability, needs emergency medical information kept on hand, or requires any other special accommodations to be shared with me in the event of a building evacuation, please contact me at extension 4248. If you need an alternative medium for communicating, or are particularly dependent on any one specific medium, please let me know before class so that appropriate accommodations can be made.

If you believe you qualify for course adaptations or special accommodations under the Americans With Disabilities Act, it is your responsibility to contact the Disabled Students Services Coordinator in the LSC and provide the appropriate documentation. If you have already documented a disability or other condition which would qualify you for special accommodations, or if you have emergency medical information or special needs I should know about, please notify me during the first week of class. You can reach me by phone at 833-9111, extension 4248. Or, you can schedule an office appointment to meet me in the SMT Office Building, office number 323 during my posted office hours or at another mutually determined time. If this location is not convenient for you, we will schedule an alternative place for the meeting. If you use an alternative medium for communicating, let me know well in advance of the meeting (at least one week) so that appropriate accommodations can be arranged.
SYLLABUS QUIZ  (Due Thursday)
NAME: ____________________ (please print)
PHYSICS 221 Section: ___________

Instructions: Read the syllabus, answer the questions below, and sign the form at the bottom indicating that you have read the syllabus. Return this to the teacher.

When are the meeting times for Physics 221A?

When are Keith’s office hours? Where is his office?

Where will you need to check out supplementary textbooks? How long can you keep one before it is due?

What happens to Physics 221 students who turn in assignments two days late? How late is too late?

What are the three lab experiments we will do some time this quarter?

When is the deadline for applying for a Pass/Fail grade? (Check the quarterly schedule.)

_____________________________     __________________________
(Signature of student)      (Date)

I have read the syllabus for Physics 221
Signed,