PHY251 Modern Physics Spring 2018

Lecture time: 8:30-9:50am Tues Thurs, Location: Physics Room P118
Instructor: **Tzu-Chieh Wei** <tzu-chieh.wei[at]stonybrook[dot]edu>
Office hour: Mon 11:00am-12:00pm (tentative), Math 6-101

Recitation Instructors:
Tzu-Chieh Wei <tzu-chieh.wei[at]stonybrook[dot]edu>
Recitation time: Tuesday 10:00AM - 10:53AM, Location: PHY128

Prof. Joanna Kiryluk <Joanna.Kiryluk (at) stonybrook[dot]edu>
Recitation time: Thursday 10:00AM - 10:53AM, Location: PHY128
Office hour: Wed 9-10am (tentative), Physics C-109

Lab TAs and Graders: **Jonathan Pachter** and **Darin Mihalik**
Office hours: TBA

[For office hours, it would be useful to email the instructor and TAs informing him/her that you will be coming.]

Course description:
A ***survey*** of the major physics theories of the 20th century (relativity and quantum mechanics) and their impact on most areas of physics. It introduces the special theory of relativity, the concepts of quantum and wave-particle duality, Schroedinger's wave equation, and other fundamentals of quantum theory as they apply to nuclei, atoms, molecules, and solids. The Laboratory component, PHY 252 (Modern Physics Laboratory), must be taken concurrently; a common grade for both courses will be assigned. Three hours lecture and one hour recitation per week, as well as laboratory work.

Prerequisite: PHY 122/124, or PHY 126 and 127, or PHY 132 or PHY 142; and PHY 134; C or higher in MAT 126 or 132 or 142 or 171 or AMS 161 Pre- or Corequisite: MAT 203 or MAT 205 or AMS 261 or MAT 307 Corequisite: PHY 252

We will cover quantum mechanics to the extent that we need for other parts of this course. PHY307 Physical and Mathematical Foundations of Quantum Mechanics is recommended after you finish PHY251. Quantum mechanics will be treated more rigorously and extensively in PHY308 Quantum Physics. Other more specialized courses you may want to consider in the future after finishing this course: PHY408 Relativity, PHY431 Nuclear and Particle Physics, PHY451 Quantum Electronics, PHY452 Lasers, PHY472 Solid State Physics, and AST347 Cosmology.

PHY252 Modern Physics Laboratory (must be taken concurrently) is administered by Prof. Matthew Dawber and has a website here.

Required Textbook :
There are many textbooks on Modern Physics. The one that I shall use as the main one is
Modern Physics for Scientists and Engineers by John Taylor, Chris Zafiratos, and Michael A. Dubson, (2nd edition) published by University Science Books or previously by Addison-Wesley (2nd edition)
[Science/Engineering Lirbary has the latter copy: use PHY251 as course name in library reserve search at http://library.stonybrook.edu/services/course-reserves/; the reserved copy is two-hour loan and would be held behind the main desk in the North Reading Room]

Recommended Textbooks:
There are a few textbooks that will complement the above Taylor, Zafiratos and Dubson in styles and materials, including

1. ***Modern Physics for Scientists and Engineers*** 2nd Edition by John Morrison (which covers fewer materials, but slightly more advanced than Taylor et al.)
This book has a website that contains applets, which can be downloaded or used online. Morrison also discusses simulations from PhET developed at the University of Colorado; see here for simulations of quantum phenomena. (Morrison's book is entirely optional.)

2. ***The Feynman Lectures on Physics, Vol. 3*** [optional] (which can be read online here): the classic Feynman Lectures are highly recommended irregardless.

There are other Modern Physics textbooks similar in style and material selection to Taylor et al., including Tipler and Llewellyn (which nicely includes Astrophysics and Cosmology), Thorton and Rex (which also includes Astrophysics and Cosmology), Serway and Moses (Cosmology is Web only), Eisberg and Resnick (classic but a bit outdated), etc

3. ***Special Relativity.*** If you are interested in reading more about relativity, there is a recent book by Dr. David Morin (Harvard University): Special Relativity - For the Enthusiastic Beginner (David Morin) [a free chapter 1 is provided for viewing]

Recommended Documentary (not much science background assumed):
I. The Fabric of the Cosmos which includes:
Episode (1) What is space?
Episode (2) The illusion of time
Episode (3) Quantum leap
Episode (4) Universe or multiverse?

II. The Mystery of Matter: Search for the Elements (which was the 37th Annual News & Documentary Emmy® Awards Winner - Outstanding Lighting Direction and Scenic Design):
Episode (1) Out of thin air (youtube link)
Episode (2) Unruly elements (youtube link)
Episode (3) Into the atom (youtube link)

III. The Secrets of Quantum Physics (BBC documentary)
part 1, part 2

Learning outcomes: After this course, you will be able to have good understanding of modern physics, to do simple estimates and calculations about the atoms, nuclei, light, and acquire basic knowledge about atomic physics, statistical physics, solid state physics, nuclear and elementary particles, and the universe. You will also have better appreication of the many scientific details about important discoveries (such as in the above documentaries).

Grades: (tentative) Note that (1) PHY252 (Modern Physics Laboratory) must be taken concurrently and it will be included as part of the grade for PHY251 and (2) Recitations are an integral part of this course and must be taken as well

Final Grading is based on:
Homework: 15%
Class participation & in-class quizzes: 5%
Recitations: 10%
Two Midterms: 20% (10% each)
Final Exam: 25%
Lab (PHY252): 25%

For example, on a scale of 0 to 100, the letter grade is assigned approximately, A: 90-100, A-: 86-89.99, B+: 80-85.99, B: 76-79.99, B-: 70-75.99, C+: 66-69.99, C: 60-65.99, C-: 56-59.99, and so on.

Homework problems may involve use of computer; you can use any programs you prefer, such as Matlab, Mathematica, Python, C/C++, Julia, Fortran, etc. Intel offers Free Software Tools for students; see also the plotting tutorials in PHY252 Modern Physics Lab. University also has licenses for Matlab and Mathematica and these softwares are available at SINC sites.

Homework policy: no late homework (must be turned in on the due day in class; exception must be requested two days or earlier before deadline; if you cannot bring homework to class, you can scan it and email it to the instructor). Grading of homework is based on some selected problems.

Recitations: homework problems will be discussed in recitations; there is also a quiz from time to time based on lectures and homework problems

*In-class quizz*es: from time to time there will be a short quizz in class, with problems from e.g. reading assignment, lectures

or homework problems.

Exams: formula sheet of one page of letter size is allowed (only formulas, not solutions to any problems); your solutions should present clear logic, cannot simply copy formulas. Since the exam is accumulative, failing to take the final exam for no valid excuses will automatically fail the course. Make-up exam needs to be scheduled with the instructor within two days of missing the exam.

Laboratory schedue is posted here

Topics to be covered and tentative syllabus
(This is a tentative syllabus. Exam dates and due dates may change. Check later for update.)
The syllabus will evolve as classes move on. Reading of sections by Taylor, Zafiratos and Dubson will be listed.

Notes (mostly from last year) can be downloaded (clickable links are provided).

1. Overview and special theory of relativity:
<reading: 1.1-1.14, 2.1-2.10> (notes: A B)
(week 1) [1/23,1/25]
(week 2) [1/30,2/1]
It is highly recommended that you watch episodes 1 and 2 of the Fabric of the Cosmos: (1) What is space? and (2) The illusion of time

2. Experiments and ideas (wave-particle duality, uncertainty principle, quantization, etc.) leading to quantum theory:
<reading: 3.10-3.12, 4.1-4.7,6.1-6.9> (notes: A B)
(week 3) [2/6,2/8]
(week 4) [2/13,2/15]
[discussions on Bohr's model of hydrogen will come until after we learn quantum mechanics in 3D and compare the two approaches]

3. Quantum mechanics in 1D:
<reading: 7.1-7.11> (notes: here)
(week 5) [2/20,2/22]
(week 6) [2/27, 3/1] In-class midterm exam I: 2/27 (closed book but a formula sheet of letter size paper, front and back, is allowed)
(week 7) [3/6, 3/8]
(week 8) Spring recess

4. Quantum mechanics in 2& 3D and atomic energy levels:
<reading: 8.1-8.10, 5.7-5.9> (notes: here)
(week 9) [3/20,3/22]
(week 10) [3/27,3/29]

5. Electron spin, multi-electron atoms, periodic table:
<reading: 9.1-9.7, 10.1-10.8> (notes: A B periodic table)
(week 11) [4/3,4/5] In-class midterm exam II: 4/3
(week 12) [4/10,4/12]

6. Statistical physics:
<reading: 15.3, 15.7-15.8 > (notes: here)
(week 13) [4/17,4/20]

7. Atomic transitions and radiation:
<reading: 11.3-11.9>
(week 14) [4/24,4/26]

8. Solid-state physics:
<reading: 13.5-13.12, 14.1-14.4, 14.8>
(week 15) [5/1,5/3]

Final exam ==> 11:15am-1:45pm Tuesday May 8, 2018 (room to be announced)

[The remaining topics will probably not be covered in this semester or covered at the expense of some of the above topics.]

9. Structure of atomic nuclei and radioactivity, particle physics:
<reading: 16.1-16.8, 17.1-17.5, 18.1-18.10>

Additional topics such as cosmology and quantum information and computation might be discussed if time permits.

Note quizzes will be based on lecture examples and previous homeworks (i.e. similar problems), so you should understand all the homework problems (even after you turn them in) and review examples done in lectures.

The notes are based on materials from the textbook.

Final exam: 11:15am to 1:45pm Tuesday May 8th, 2018; see Registrar

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Recommended additional reading and viewing:

1. Special Relativity in a Nutshell
2. Einstein's Big Idea
3. A Trip Through Spacetime
4. Putting Relativity to the Test
5. Inside Einstein's Mind
6. The Amazing Atomic Clock
7. The Fabric of the Cosmos
8. Hunting the Elements
9. The Mystery of Matter: Search for the Elements
10. Does Antimatter Fall Up or Down?
11. Origins: Back to the Beginning
12. Big Bang Machine
13. Relativity and the Cosmos
14. How Big Is the Universe?
15. A Quantum Leap in Computing

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Announcement, Update and Additional Information

More will be posted to Blackboard.stonybrook.edu

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For your information:

A brief guide to 'Student Success Resources' that are available on our campus:
https://ucolleges.stonybrook.edu/links/academic-success-resources.pdf

Americans with Disabilities Act:
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services (631) 632-6748. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students requiring emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information, go to the following web site http://studentaffairs.stonybrook.edu/dss/

Academic Integrity:
Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology &

Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Critical Incident Management:
Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Electronic Communication:
Email to your University email account is an important way of communicating with you for this course. For most students the email address is 'firstname.lastname@stonybrook.edu', and the account can be accessed here: http://www.stonybrook.edu/mycloud. *It is your responsibility to read your email received at this account.*

For instructions about how to verify your University email address see this: http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo . You can set up email forwarding
using instructions here: http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail . If you choose to forward your University email to another account, we are not responsible for any undeliverable messages.

Religious Observances:
See the policy statement regarding religious holidays at http://www.stonybrook.edu/registrar/forms/RelHolPol%20081612%20cr.pdf Students are expected to notify the course professors by email of their intention to take time out for religious observance. This should be done as soon as possible but definitely before the end of the 'add/drop' period. At that time they can discuss with the instructor(s) how they will be able to make up the work covered.

Instructional/Student Responsibilities: the University Senate's Undergraduate Council updated The University's statement of Minimal Instruction and Student Responsibilities in Fall 2008. Also listed are the Minimal Undergraduate Student Responsibilities. Both statements may be found in the Academic Policies and Regulations section of the on-line Undergraduate Bulletin:
http://sb.cc.stonybrook.edu/bulletin/current/policiesandregulations/policies_expectations/min_instructional_student_resp.php.

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