Lecture Notes on the quantum mechanics (graduate course)

Phys.524 (Quantum Mechanics I, Fall 2016)

Phys.525 (Quantum Mechanics II, Spring 2017)

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Here I present Lectures Notes on quantum mechanics (graduate course) which were written during the classes. I uses Sakurai and Napolitano, Modern Quantum Mechanics as a textbook. Note that these notes are rather different from those of Phys.421 and Phys.422 (quantum mechanics, undergraduate course), since many new topics such as Berry phase and Dirac relativistic electron theory, and so on are included in these lecture notes. The Mathematica was extensively used for the calculations such as matrices of angular momentum and Kronecker Product, and so on. Although these lecture notes are far from completeness, I hope that these notes may be useful for the understanding of quantum mechanics for graduate students as well as researchers who are interested in these topics. Note that I spent so much time in preparing these lecture notes. I have some difficulty in putting topics of these lecture notes in order. So I decide to put the topics in alphabetical order just like a dictionary.

Syllabus of Phys.524 and Phys.525):

Course Objectives: To understand the basic concepts underlying Quantum Mechanics and to be able to independently solve corresponding problems.

CRN: 17175
Credit: 4.00

Instructor:

Masatsugu Sei Suzuki

Full Professor of the Physics Department
Undergraduate Program Director
Office: Room 2048, Smart Energy (SN)

Class hours (lectures):

T, R: 1:15 - 2:40 PM SII-260

Office Hours:

T, R: 3:00 – 4:30 PM SII 157A

Textbook:

J.J. Sakurai and Jim Napolitano, Modern Quantum Mechanics Second Edition
Addison-Wesley (2011):
ISBN: 10: 0-8053-8291-7
ISBN-13: 978-0-8053-8291-4

Text Coverage:

The chapters 1-5 were discussed in Quantum Mechanics I (Phys.524 Fall 2016) and the chapters 5-8 were discussed in Quantum mechanics II (Phys525, Spring 2017).

List of books reserved in the Newcomb Reading Room in the Library North

1. S. Weinberg, *Lectures on Quantum Mechanics* (Cambridge University Press, 2013). ISBN 978-1-107-02872-2
2. E. Merzbacher, *Quantum Mechanics*, third edition (John Wiley & Sons, New York, 1998). ISBN 0-471-88702-1
3. R. Shankar, Principles of Quantum Mechanics, 2nd edition (Plenum Press, 1994). ISBN 0-306-44790-8.
4. Claude Cohen-Tannoudji, Bernard Diu, and Franck Laloë, *Quantum Mechanics*, volume I and volume II (John Wiley & Sons, New York, 1977).
5. G. Auletta, M. Fortunato, and G. Parisi, *Quantum Mechanics* (Cambridge University Press, 2009). ISBN-13 978-0-521-86963-8
6. M.L. Bellac, *Quantum Physics* (Cambridge University Press, 2006). ISBN-10 0-521-85277-3
7. G. Baym, Lectures on Quantum Mechanics (Westview Press, 1990). ISBN 0-8053-0667-6
8. J. Schwinger, *Quantum Mechanics* (Springer, Berlin, 2001). ISBN 3-540-41408-8
9. R. P. Feynman and Albert R. Hibbs, *Quantum Mechanics and Path Integrals*, emended by Daniel F. Styer, Emended edition (Dover Publications, Inc. New York, 2010). ISBN-13 978-0-486-47744-0
10. J. Binney and D. Skinner, *The Physics of Quantum Mechanics* (Oxford, 2014). ISBN 978-0-19-968857-9
11. A. Das, *Lecture on Quantum Mechanics* (World Scientific, 2012). ISBN-13 978-981-4374-38-5
12. N. Zettili, *Quantum Mechanics, Concepts and Applications*, 2nd edition (John Wiley & Sons, New York, 2009). ISBN 0-471 48943 3.

Mathematica 11: (not required)

You can get a Mathematica 11 from the on-line. Binghamton University has a license for the Mathematica 11. The SUNY system gets a license to use the Mathematica 11 for all students and faculties in the Binghamton University. I will show how to use the Mathematica 11 during the class. As a part of the demonstration, I will also show the programs which I will make.

Examinations:

Calculator: Students are allowed to use a programmable calculator during the examinations. Three exams will be given during the classes. A required final examination will be given during examination week. Quizzes will be given during the class. Open-book examination (you may use the textbook during the examination).

Homeworks:

All the homeworks are chosen from the problems in the text book (Sakurai 2^{nd} edition). Homework solutions should be submitted before the due date. The problem numbers for each homework are listed below.

SP (selected problems) solution

I want you to solve all the problems of the textbook. However, since there are so many problems in the textbook, I put the solutions of the selected problems of the textbook in the Blackboard. So you can solve the problems by yourself and compare your solution with the solutions of Sakurai and mine. These SP solutions will help you in solving the homework problems.

Exams:

There are three Hour Exams and one final exam. All problems will be chosen from both the homeworks and specified problems of SP. I will let you know the detail before each examination. The problems of the examinations are not always the same. I will modify the problems and add several questions.

Final Grade Determination:

Your final grade will be based on an absolute scale. Your final grade will be based on the three one-hour examinations (actually two Exams out of three Exams), the final exam, the lab grade, the home work grade, and the discussion grade as follows:

200 points	for best two of the three regular exams (see below)
200 points	for the final exam
100 points	for the home work
50 points	for the quiz (made at the middle of each chapter)
50 points	attendance for lecture class
600 points	total possible points for the course

Grade:

Your final grade will be determined by the percentage of 600 total points you manage to attain. These grades may change depending on the graph of the number of people vs total points such as Gaussian distribution with a single peak or double peaks.

85-100	A
80-84	A^-
75-79	B^+
70-74	B
65-69	B^-
60-64	C^+
55-59	C
50-54	C^-
40-49	D
0-39	F

Blackboard:

We have established a system where you can access exam solutions and administrative announcements from any on or off campus computer.

Announcements, Lecture note, Solutions of homeworks, Mathematica programs, Web site links, E-mail, and so on

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