STATE UNIVERSITY OF NEW YORK AT BINGHAMTON
Department of Physics

Syllabus
PHYS. 422/ 509
Quantum Mechanics II
Spring 2015 (1/26 – 5/08/15)
(Revised: January 10, 2015)

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

CRN	20469 (Phys.422)	Credit:	4.00
CRN	20482 (Phys.509)	Credit:	4.00

Instructor:

Masatsugu Sei Suzuki

Full Professor of the Physics Department

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Wikipedia http://en.wikipedia.org/wiki/Masatsugu_Suzuki

Category:

American Physicists

http://en.wikipedia.org/wiki/Category:American_physicists

Curriculum Vita of the Instructor

Education: Ph.D. (March 1977) Physics, University of Tokyo, Japan.

Positions held

Professor, Department of Physics, State University of New York at Binghamton, Binghamton, New York 13902-6000 (9/86 – present)

Visiting Professor, Institute for Molecular Science, Myodaiji, Okazaki 444, Japan (8/92 - 12/92)

Visiting Scientist, Schlumberger-Doll Research, Ridgefield, Connecticut 06877 (11/85 - 8/86)

Visiting Research Assistant Professor, Department of Physics, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801 (7/84 - 8/86)

Research Associate, Department of Physics, Ochanomizu University, Tokyo, Japan (4/77 - 8/86)

Class hours (lectures):

T, R:	10:05 – 11:30 AM	SII-260	(Lecture)
W	4:40 - 5:40 PM	LN G209	(Discussion)

Office Hours:

Tuesday and Thursday: 1:00 – 3:00 PM
Friday: 10:00 - 11:00 AM
(Science II, Room 157A)

Lecture Notes (Blackboard):

These notes are made from my experience of teaching in Quantum Mechanics since 1986. The contents of the notes are not always the same as those of the textbook (Townsend), and are much more extensive. The lecture notes of Phys.421/508 (Fall 2014) will be at my web site: http://bingweb.binghamton.edu/~suzuki/research.html.

Attendance

You may not be qualified for taking the final exam if the percentage of your attendance is less than 33%.

Textbook:

A Modern Approach to Quantum Mechanics
John S. Townsend (University Science Books, 2012) second edition
ISBN: 978-1-891389-78-8

I will also use the following book for the discussion;

David H. McIntyre, Quantum Mechanics, A Paradigms Approach.
N. Zettili, Quantum Mechanics Concepts and Applications, 2nd edition (John-Wiley & *Sons, New York, 2009).*

Text Coverage:

We will follow the textbook by Townsend, focussing on selected topics of chapters 8-14.

Outline: (See table of contents of book for detail)

1. Feynman path integral
2. Hydrogen atom
3. Time independent perturbation theory

4. Time dependent perturbation theory
5. Zeeman effect and Stark effect
6. Addition of angular momentum; Clebsch-Gordan co-efficient
7. Wigner-Eckart theorem
8. Identical particles
9. Scattering
10. Photon and atoms
11. Quantization of radiation field
14. Relativistic Dirac electron theory
13. Quantum information processing
14. Manipulating atoms with quantum mechanical forces
15. WKB approximation
16. Kronecker product; how to construct the wave functions of many electrons

All the References related to quantum mechanics, which I know, will be put in my web site: http://bingweb.binghamton.edu/~suzuki/research.html.

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

1. John S. Townsend , A Modern Approach to Quantum Mechanics (University Science Books, 2000). This is our textbook. ISBN: 978-1-891389-78-8
2. David J. Griffiths, Introduction to Quantum Mechanics (Prentice Hall, Englewood Cliff, NJ). ISBN-13: 978-0131118928 | Edition: 2nd edition
3. Stephen Gasiorowicz, Quantum Mechanics (John Wiley & Sons, Inc., New York, 1974). Publication Date: April 17, 2003 | ISBN-10: 0471057002 | ISBN-13: 978-0471057000 | Edition: 3
4. Richard L. Liboff, Introductory Quantum Mechanics, 4th edition (Addison Wesley, New York, 2003). Publication Date: August 18, 2002 | ISBN-10: 0805387145 | ISBN-13: 978-0805387148 | Edition: 4
5. Schaum's Outline of Theory and Problems of Quantum Mechanics, Yoav Peleg, Reuven, and Elyahu Zaarur (McGraw-Hill, New York, 1998). Publication Date: April 30, 1998 | ISBN-10: 0070540187 | ISBN-13: 978-0070540187 | Edition: 1
6. J.J. Sakurai, Modern Quantum Mechanics, Revised Version (Addison-Wesley, New York, 1994). Publication Date: September 10, 1993 | ISBN-10: 0201539292 | ISBN-13: 978-0201539295 | Edition: 1
7. Eugen Merzbacher, Quantum Mechanics, 3rd edition (John Wiley & Sons, New York, 1998). Publication Date: December 1997 | ISBN-10: 0471887021 | ISBN-13: 978-0471887027 | Edition: 3
8. Nouredine Zettili, Quantum Mechanics, Concepts and Applications, 2nd edition (John Wiley & Sons, New York, 2009). Publication Date: February 24, 2009 | ISBN-10: 0470026790 | ISBN-13: 978-0470026793 | Edition: 2

8. Ramamurti Shankar, Principles of Quantum Mechanics, 2nd edition (Springer, New York, 1994). Publication Date: September 1, 1994 | ISBN-10: 0306447908 | ISBN-13: 978-0306447907 | Edition: 2nd
9. Claude Cohen-Tannoudji, Bernard Diu, and Franck Laloë, Quantum Mechanics volume I and volume II (John Wiley & Sons, New York, 1977). Publication Date: November 3, 1992 | ISBN-10: 0471569526 | ISBN-13: 978-0471569527 | Edition: 2 Volume Set
10. D.H. McIntyre, Quantum Mechanics , A Paradigms Approach (Pearson, 2012). Publication Date: January 22, 2012 | ISBN-10: 0321765796 | ISBN-13: 978-0321765796 | Edition: 1
11. M.L. Bellac, *Quantum Physics* (Cambridge, 2006).
12. J. Binney and D. Skinner, *The Physics of Quantum Mechanics* (Oxford, 2014).

References: as Textbook (undergraduate courses)

1. David J. Griffiths, Introduction to Quantum Mechanics (Prentice Hall, Englewood Cliff, NJ, 1995).
2. Stephen Gasiorowicz, Quantum Mechanics (John Wiley & Sons, Inc., New York, 1974).
3. Richard L. Liboff, Introductory Quantum Mechanics, 4th edition (Addison Wesley, New York, 2003).
4. David Park, Introduction to the Quantum Theory, 3rd edition (McGraw-Hill, Inc., New York, 1992).
5. Nevil F. Mott, Elementary Quantum Mechanics (Wykeham Publications (London) Ltd, London, 1972).
6. Bruce C. Reed, Quantum Mechanics (Jones and Bartlett Publications, Boston, 2008).
7. Schaum's Outline of Theory and Problems of Quantum Mechanics, Yoav Peleg, Reuven, and Elyahu Zaarur (McGraw-Hill, New York, 1998). This is my favorite book.
8. A.C. Phillips, Introduction to Quantum Mechanics (John Wiley & Sons, New York, 2003).
9. J. Binney and D. Skinner, *The Physics of Quantum Mechanics* (Oxford, 2014).

References: as Textbook (graduate courses)

1. J.J. Sakurai, Modern Quantum Mechanics, Revised Version (Addison-Wesley, New York, 1994).
2. Eugen Merzbacher, Quantum Mechanics, 3rd edition (John Wiley & Sons, New York, 1998).
3. Leonard Schiff, Quantum Mechanics (McGraw-Hill Book Company, Inc, New York, 1955).
4. David. Bohm, Quantum Theory (Dover Publication, Inc, New York, 1979).
5. Albert Messiah, Quantum Mechanics vol.I and vol.II (North-Holland, 1961).
6. Ramamurti Shankar, Principles of Quantum Mechanics, 2nd edition (Springer, New York, 1994).

7. Claude Cohen-Tannoudji, Bernard Diu, and Franck Laloë, Quantum Mechanics volume I and volume II (John Wiley & Sons, New York, 1977).
8. N. Zettili, Quantum Mechanics Concepts and Applications, 2nd edition (John-Wiley & *Sons, New York, 2009).*
9. F. Schwabl, Quantum Mechanics, 4-th edition (Springer Verlag, Berlin, 2007).
10. M.L. Bellac, *Quantum Physics* (Cambridge, 2006).
11. G. Auletta, M. Fortunato, and G. Parisi, *Quantum Mechanics* (Cambridge, 2009).
12. J. Binney and D. Skinner, *The Physics of Quantum Mechanics* (Oxford, 2014).

References; Textbooks (Advanced courses)

1. Paul .A.M. Dirac, The Principles of Quantum Mechanics, 4-th edition (Oxford University Press, Oxford, 1958).
2. Werner Heisenberg, The Principles of the Quantum Theory (Dover Publications, Inc., New York, 1949).
3. Albert Messiah, Quantum Mechanics (Dover Publications, Inc., New York, 1999).
4. Julian Schwinger, Quantum Mechanics (Springer, Berlin, 2001).
5. Richard P. Feynman and Albert R. Hibbs, Quantum Mechanics and Path Integrals, emended by Daniel F. Styer, Emended edition (Dover Publications, Inc. New York, 2010).
6. J.D. Bjorken and S.D. Drell (McGraw-Hill Book Company, New York, 1964).
7. J.J. Sakurai, Advanced Quantum Mechanics (Addison-Wesley, New York, 1967).
8. A.S. Davydov, Quantum Mechanics (Pergamon Press, Oxford, 1965).
9. L.D. Landau and E.M. Lifshitz, Quantum Mechanics (Pergamon Press, Oxford, 1977).
10. A. Messiah, Quantum Mechanics vol.I and vol.II (North-Holland, 1961).
11. S.S. Schweber, An Introduction to Relativistic Quantum Field Theory (Row, Peteson and Company, Evanston, Illinois, 1961).

Mathematica 10.0: (not required):

You can also get it from Mark Stephens of the Physics Department. You can also get a Mathamatica 10.0 from the on-line. Binghamton University has a license for the Mathematica 10.0. The SUNY system gets a license to use the Mathematica 10.0 for all students and faculties in the Binghamton University. I will show how to use the Mathematica 10.0 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 one-hour (1 hour) exams will be given during the classes (discussion). A required final examination will be given during examination week. Quizzes will be given in discussion. You may bring one 3"x5" file card hand written on one side with any material you see fit into each 1 hour examination. All the examination problems will be chosen mainly from home works and

problems of the textbook which will not included in the homeworks but will be discussed in the Discussion Section. Problems are appropriately modified, with the addition of new 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 one-hour exams (see below)
200 points	for the final exam
50 points	for the discussion grade (Quiz)
100 points	for the home work
50 points	attendance for lecture class
600 points	total possible points for the course

There will be no make-up examinations:.

To accommodate a personal "crisis" coinciding with the day of an examination, such that a student misses the examination or performs below his or her normal level, one of the hour exam grades will be dropped. No excuse is necessary for missing or doing poorly on the hour exam which will not be counted - you could break your leg, be "sick" from a party, your alarm clock fails, etc. - regardless of the excuse, your worst 100 examination points will not be counted. THE FINAL EXAM MUST BE TAKEN.

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

Discussion:

In discussion, concepts presented in lecture will be reviewed and new concepts and

approaches to problem solving may be introduced. Try to use these sessions to get your questions answered. Your discussion grade will be based on: your performance in a series of short quizzes, and, possibly, on a judgment based upon your participation in discussion. The evaluation will be made from quizzes and attendance.

We discuss the solution of selected problems (nice problems) which are chosen from textbooks (Townsend). All the solutions of the textbook will be posted in the Blackboard in appropriate times.

Exam solutions:

Solutions for examinations will be posted on Blackboard.

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

Time Guidelines:

We expect that you will spend a minimum of ten hours each week outside of class working on the course. You should spend twenty minutes before each lecture scanning the textbook to get an idea as to what we will be covering in the lecture and the approach we will be using. This small investment of time will pay dividends in making the time spent in lecture more useful in the learning process. After each lecture, you should spend one hour learning the material covered in the lecture by reviewing your lecture notes and reading the textbook in detail. Each assigned problem set should take about three hours to complete; In this course, you cannot skip a week's worth of work and double up the time spent the following week. Cramming and pulling an "all nighter" to prepare for an examination is effectively dooming yourself to non-success. Success is produced by not getting behind and doing something everyday.

Disclaimer:

We reserve the right to alter conditions and items found in this document at any time in the course of the semester using an announcement made in a scheduled lecture session and a Blackboard.

Students with disabilities:

If you are a student entitled to extra time on examinations or some other accommodation, you must see us before the accommodation can be made for you. You must bring the appropriate letter from the Services for Students with Disabilities Office along with you.

Students in Intercollegiate Sports:

It is the responsibility of students participating in intercollegiate athletics and thereby must be away from campus to make up any assigned work. You must make appropriate arrangements with your instructor (lab, discussion, or lecture) in advance.

Examination re-grading policy:

If after reviewing the posted examination solutions, you believe you deserve more points for a given problem, you must submit a written explanation of why you deserve more credit for the problem. The note must also include a signed statement that you have made no changes on the item in question. We will have copied approximately a quarter of the exams submitted. If a change has been made on an answer resubmitted, you will receive a zero on the exam and be referred to the Arts and Sciences academic honesty committee. The request for a re-grade is to be submitted to either your instructor or your discussion leader. **The request should be made within one week after you receive your exam sheet.**

Important Remarks and Advice:

1. We are aware that this course will cover a lot of ground and will be a lot of work for you.
2. Keep up with your work.
   Read the appropriate sections of the text, once, before the lecture. As soon as possible after lecture, go over your notes and the text.
4. Do the problems! It is the only true test of whether you really understand the physics.
5. For each topic, collect a set of typical problems you can solve associated with that topic. Remember how you solve them.
6. Compare and integrate what you see in the text, lecture, discussion, lab, and the assigned problems. It is all part of one course, and the better you see how the pieces fit together, the more sense it will make.
7. The person who has the biggest part in determining what you will get out of this course (abilities, knowledge, and grade) is YOU.

Our Suggestions for Success in the Course:

Come to class. There is little we can do to help you learn the subject if you are not there. When you are in class, do something productive. Take notes. Writing down the material is the first mechanical link to learning.

Within a day, review your notes, rewrite if necessary, compare your notes with the development in the textbook, and make sure you understand the examples worked.

Start the homework well before it is due. If you are having difficulty; ask your discussion leader, come to an office hour, or access one of the Mastering Physics hints. It is impossible to provide you help if you start an assignment two hours before the time it is due.

Make sure you can eventually do all homework problems and examples worked **WITH YOUR BOOK CLOSED, OR WITH YOUR COMPUTER SCREEN DARK.** You are not doing Physics "Appreciation"; you have to do the physics yourself. This is the place where most

students have extreme difficulties.

SP problems and solutions

The solutions of the problems in the textbook (Townsend) which are not given as homeworks, are presented in the Blackboard. These may help you in solving homeworks since these are sometimes similar to the problems of homeworks.

SP-8 (Chapter 8);	**problems**	**2, 6**
SP-9 (Chapter 9):	problems	**2, 3, 6, 8, 10, 13, 15, 18, 19, 22, 23**
SP-10 (Chapter 10)	problems	**4, 5, 7, 8, 8, 12, 16, 18**
SP-11 (Chapter 11)	problems	**7, 12, 13, 15, 16, 17, 18**
SP-12 (Chapter 12)	problems	**2, 6**
SP-13 (Chapter 13)	problems	**7, 12**
SP-14 (Chapter 14)	problems	**2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19**

Schedule of Classes in Phys.421 and Phys.508 (Spring 2015):

	Date	Topics
Week-1	27 January T	Lecture-1 Chapter 8
	28 January W	Lecture-2 Chapter 8
	29 January R	Lecture-3 Chapter 8
Week-2	03 February T	Lecture-4 Chapter 9
	04 February W	Discussion-1 Quiz-1
	05 February R	Lecture-5 Chapter 9
Week-3	10 February T	Lecture-6 Chapter 9
	11 February W	Discussion-2 Quiz-2
	12 February R	Lecture-7 Chapter 9
Week-4	17 February T	Lecture-8 Chapter 10
	18 February W	Discussion-3 Quiz-3

	19 February R	Lecture-9 Chapter 10
Week-5	24 February T	Lecture-10 Chapter 10
	25 February W	Discussion-4 Quiz-4
	26 February R	Lecture-11 Chapter 10
Week-6	03 March T	Lecture-12 Chapter 10
	04 March W	Hour Exam-1 Chapters 8, 9, 10
	05 March R	Lecture-13 Chapter 11
Week-7	10March T	Lecture-14 Chapter 11
	11 March W	Discussion-5 Quiz-5
	12 March R	Lecture-15 Chapter 11
Week-8	17 March T	Lecturte-16 Chapter 11
	18 March W	Discussion-6 Quiz-6
	19 March R	Lecture-17 Chapter 12
Week-9	24 March T	Lecture-18 Chapter 12
	25 March W	Discussion-7 Quiz-7
	26 March R	Lecture-19 Chapter 12
Week-10	31 March T	Lecture-20 Chapter 12
	01 April W	Hour-Exam 2 Chapters 11 and 12 (HW and quiz)
	02 April R	Lecture-21 Chapter 13
Week-11	07 April T	Spring Recess

	08 April W	Spring Recess
	09 April R	Spring Recess
Week-12	14 April T	Lecture-22 Chapter 13
	15 April W	Discussion-8 Quiz-8
	16 April R	Lecture-23 Chapter 13
Week-13	21 April T	Lecture-24 Chapter 13
	22 April W	Discussion-9 Quiz-9
	23 April R	Lecture-25 Chapter 14
Week-14	28 April T	Lecture-26 Chapter 14
	29 April W	Discussion-10 Quiz-10
	30 April R	Lecture-27 Chapter 14
Week-15	05 May T	Lecture-28 Chapter 14
	06 May W	Hour exam-III (Chapter 13, a part of Chapter 14)
	07 May R	Lecture-29 Review for final exam
Final Exam		Final Exam Chapters 8-14

Homework Assignments

Townsend (second edition). You will find the pdf form of the problems of second edition.

Name	Chapter	Problems	Acceptance Period
HW01	Chapter 8	1, 3, ,4, 5	2/02/14 (M) 3:00 PM

HW02	Chapter 9	1, 4, 5, 7	2/5 (R) 3:00 PM
HW03	Chapter 9	9, 11, 12, ,14	2/10 (T) 3:00 PM
HW04	Chapter 9	16, 17, 20, 21	2/16 (M) 3:00 PM
HW05	Chapter 10	1, 2, 3, 6	2/19 (R) 3:00 PM
HW06	Chapter 10	8, 10, 11, 13	2/25 (W) 3:00 PM
HW07	Chapter 10	14, 15, 17, 19	3/02 (M) 3:00 PM
HW08	Chapter 11	1, 2, 3, 4	3/09 (M) 3:00 PM
HW09	Chapter 11	5, 6, 8, 9	3/13 (F) 3:00 PM
HW10	Chapter 11	10, 11, 14, 19	3/20 (F) 3:00 PM
HW11	Chapter 12	1, 3, 4, 5	3/25 (W) 3:00 PM
HW12	Chapter 12	7, 8, 9, 10	4/02 (R) 3:00 PM
HW13	Chapter 13	1, 2, 3, 4	4/14 (T) 3:00 PM
HW14	Chapter 13	5, 6, 8, 9	4/21 (T) 1:00 PM
HW15	Chapter 13	10, 11, **13**	4/28 (T) 1:00 PM
HW16	Chapter 14	1, 3, 4	5/05 (T) 3:00 PM