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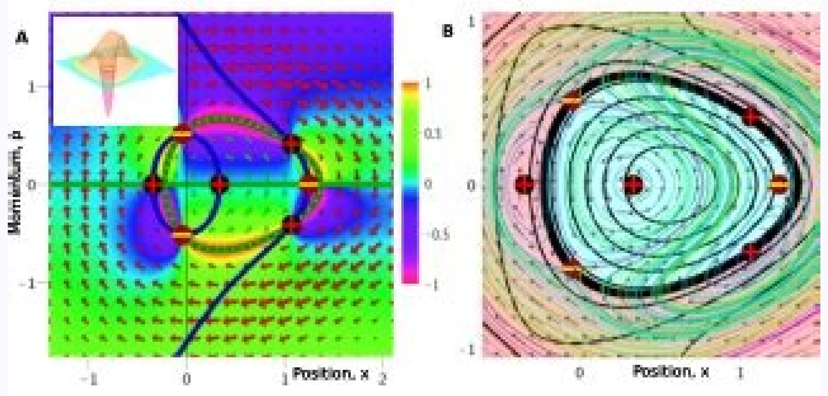


$f(x)$	Any function of position, such as x, or potential V(x)	$f(x)$
p_x	x component of momentum (y and z same form)	$\frac{\hbar}{i}\frac{\partial}{\partial x}$
E	Hamiltonian (time independent)	$\frac{p_{op}^2}{2m} + V(x)$
E	Hamiltonian (time dependent)	$i\hbar\frac{\partial}{\partial t}$
KE	Kinetic energy	$\frac{-\hbar^2}{2m}\frac{\partial^2}{\partial x^2}$
L_z	z component of angular momentum	$-i\hbar\frac{\partial}{\partial \phi}$

Q2) a) What is harmonic perturbation? Calculate transition probability per unit radiation of intensity of a harmonic perturbation. **[8]**

b) State connection formulae for WKB approximation. Obtain the Bohr - Sommerfeld quantum condition for potential well. **[8]**

Q3) a) Deduce the expression for scattering amplitude using Born Approximation for a potential given as

$$V(r) = -V_0 \quad r < a$$
$$= 0 \quad r > a$$

Also find total scattering cross - section in the low energy limit. **[8]**

b) Discuss the time - independent perturbation theory for non - degenerate stationary state. Obtain first order corrected eigen functions and eigen values. **[8]**

Q4) a) Construct symmetric and antisymmetric wave - functions for two - electron atoms. **[8]**

b) The infinite square potential well is described by

$$V = 0 \quad -a < x < a$$
$$V = \infty \quad |x| > a$$

Using trial wave function $\psi(x) = (a^2 - x^2)(1 + \alpha x^2)$ estimate the ground state energy by variational method. α is variational parameter. **[8]**

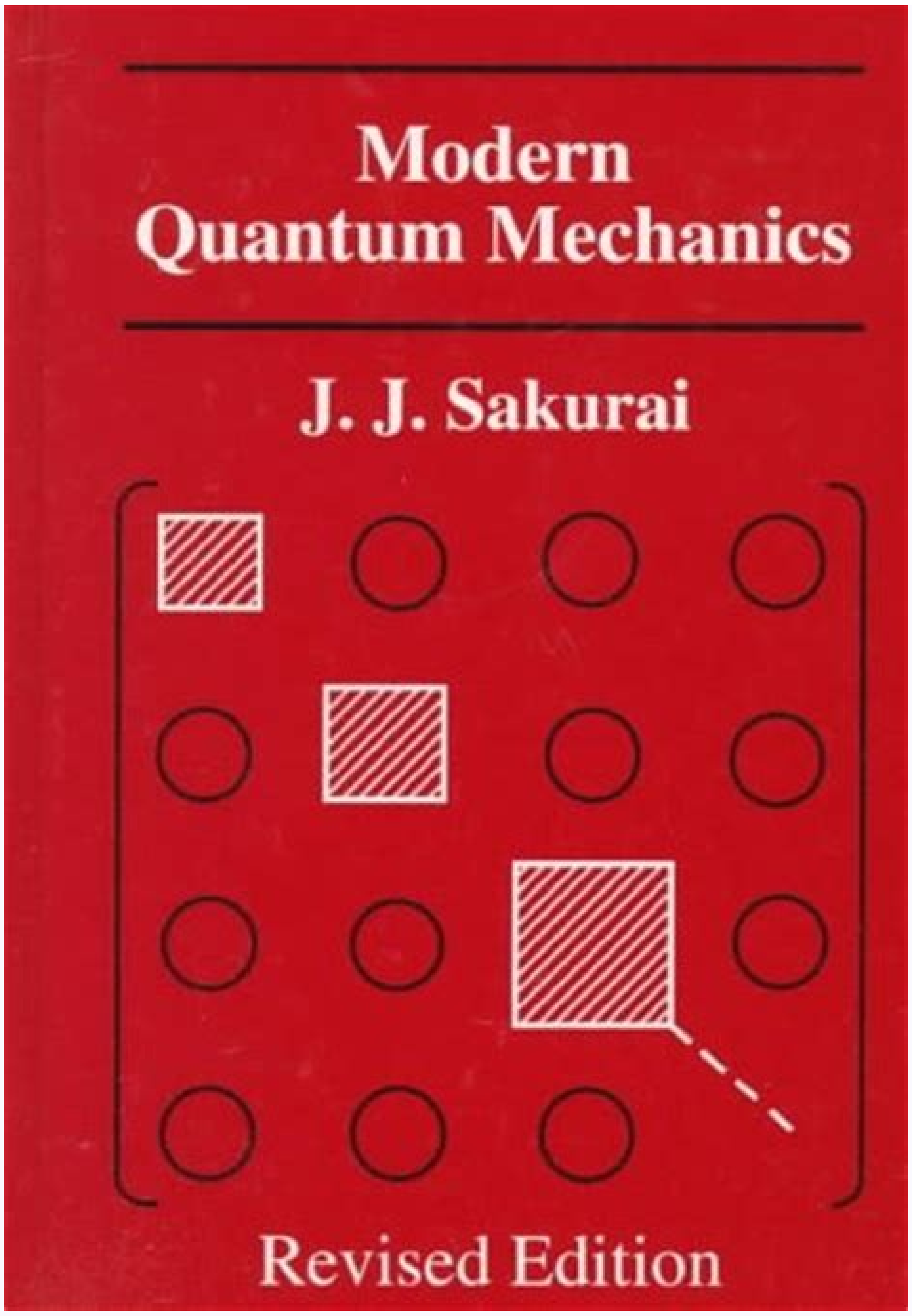
Q5) a) Using WKB method obtain expression of transmission for a slowly varying potential barrier $V(x)$. **[8]**

b) Show that the Born scattering amplitude is proportional to the spatial Fourier transform of the scattering potential with respect to the momentum transfer. **[8]**

Q6) a) A one - dimensional harmonic oscillator with angular frequency w_0 and electric charge 'q' is perturbed by an electric field ε such that the perturbation is $H'(t) = -q\varepsilon x$ for $0 \le t \le t$. Using first order perturbation theory, calculate the probability of transition from ground state to first excited state. **[8]**

b) Using partial wave analysis show that the total scattering cross - section is given by

$$\sigma = \frac{4\pi}{k^2}\sum_{l=0}^{\infty}(2l+1)\sin^2\delta_l$$ **[8]**



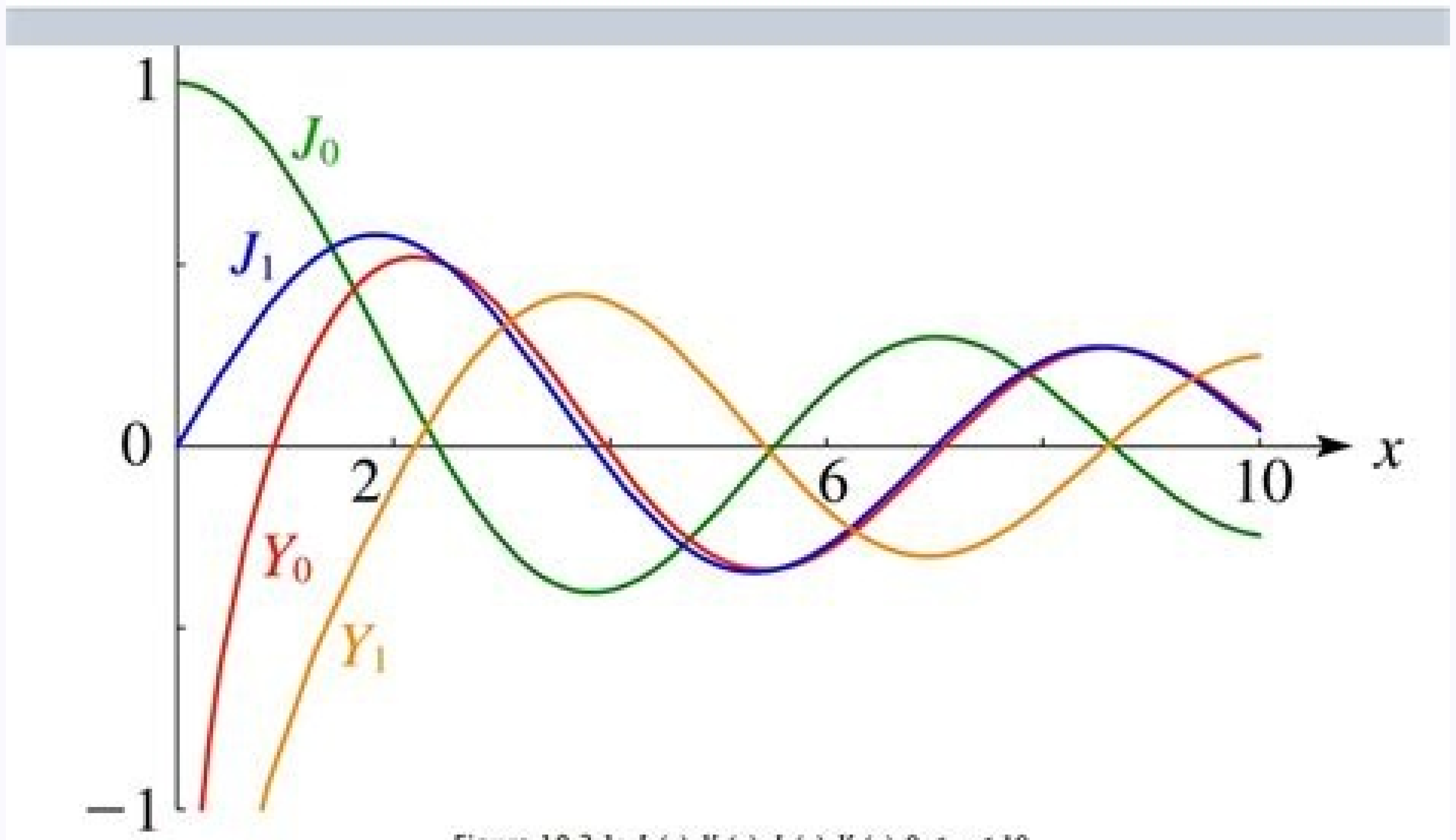


Figure 10.3.1: $J_0(x), Y_0(x), J_1(x), Y_1(x), 0 \leq x \leq 10.$

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You are using an out of date browser. It may not display this or other websites correctly.You should upgrade or use an alternative browser. Thread starter Leo32 Start date Jan 13, 2005 Hi, I'm trying very hard to study Quantum Mechanics on my own using Shankar's "Principals of Quantum Mechanics". Although the number of exercises is quite small, no answers are given. Do any of you know of a site where I might verify my results ? Greetz, Leo Answers and Replies Last edited by a moderator: Apr 22, 2017 Shankar Solutions I'm also looking for them, or at least just the answers to verify mine, if anybody knows where to look please give me a heads up on it, thanks Why does the preface of the book say a solution is provided to every problem when that's clearly not true? -Mike You could try e-mailing the author. Anybody has his email? Maybe he meant it's possible to solve all the questions in the book!(??) The Physics 486-487 sequence provides an introduction to quantum physics for majors and grad students in Physics, ECE, Materials Science, Chemistry, etc. The course starts by introducing the basic concepts of quantum mechanics: What is a quantum state and what are the rules that specify how it can change and ends by realizing that exactly computing properties of states is hard and sophisticated approximations are required. In between we will see both the exotic parts of quantum mechanics and how to demystify many of these aspects. Announcements HW8 solution posted. HW6 is now posted. HW1 solution posted. HW5 is now posted. HW's are now generically due on Thursday. HW4 is now due on Thursday Suggested readings are now up to date. Bryan's office hours have now been moved to the TA commons room Srivatsan office hours have now been moved to 1:15-2:15 PM on Sunday in the interaction room. Typos/Simplifications to HW 2: In 3c, you may choose t=1 In 3d, you may choose t=1 In 3e, you may choose t=1 In 3g, it doesn't matter what t you choose. (Think about why this is) In 3h, by trial and error you can find the correct t. In 3i it doesn't matter what t you choose. You don't have to do 3j For probem 2, you may use the mapping k(n) -> 2*pi*n For problem 2, to get the normalization to work out the basis in HW1 needs a 1/sqrt(10) in it. You will still get credit if you don't include this but certain sanity checks won't work out otherwise. HW 2 and 3 deadlines have been extended by 24 hours There appears to be open slots now. If you haven't registered yet, you should try to. Srivatsan office hours have been moved to Sunday. HW 2 now posted. Lectures 2 and 3 now posted. There are some modifications to HW1 to remove typos/make problems a bit easier. They are: Question 3: Use \delta K = 0.1 Question 3a: The state shouldn't be from -infinity to infinity (since it can't be normalized). Calculate where the envelope function hits zero first to the left and right of x=0 and the use this as the range for the integral. Question 4b: There is a missing ket in the |k> = \sum_{x=0}^9 e^{2pi n (0.1)x} | 0.1x> Question 5: It should be cos(theta/2) |0> + e^{i\phi} sin(\theta/2) |1> Question 5b: As the gamma(alpha, beta) term gets dropped anyway, you don't have to solve for it. Question 2c: The second measurement means the one in the XY basis no matter when you choose to measure with this. HW1 has now been posted. Notes for lecture 1 has been posted. Class begins Tuesday August 26 at 9:30 There will be discussion on August 28. Course Times Lectures: Tue, Thu: 9:30 - 10:50 AM in 103 Talbot Laboratory Discussions: Thursday Afternoon/Evening in 35 Loomis Laboratory D0: 3:00-4:30 R (Xiongjie) D1: 4:30-5:50 R (Xiongjie) D2: 6:00-7:20 R (Xiongjie) D3: 7:30-8:50 R (Garrett) Office Hours: Mon: 5:15 - 6:15 Gabi (third floor common area of ESB) Tue: 11:00 AM - 12:00 AM Jitong (third floor common area of ESB) Tue: 3:00 pm - 4:00 pm Garrett (third floor common area of ESB) Tue: 4:00 pm - 5:00 pm Bryan (TA Commons room) Wed: 9:00 AM - 10:00 AM Xiongjie (third floor common area of ESB) Sunday: 1:15 PM - 2:15 PM Srivatsan (Loomis Interaction Room) Instructor Prof. Bryan Clark e-mail: bkclark_at_illinois_dot_edu office: 2111 Engineering Sciences Building (ESB) Garrett Vanacore e-mail: vanacor2_at_illinois_dot_edu office: 4121 Engineering Sciences Building (ESB) Xiongjie Yu e-mail: xyu40_at_illinois_dot_edu Homework Graders Srivatsan Balakrishnan (Homeworks 1,4,7,10) email: sblkrsh2_at_llinois_dot_edu Jitong Yu (Homeworks 2,5,8,11,14) e-mail: jyu23 at illinois.edu Gabi Petrica (Homeworks 3,6,9,12,13) e-mail: petrica2 at illinois.edu Homework Homework sets will be due every Wednesday (excepting Aug. 27) by 9PM. Homework sets should be placed in the 486 homework box (located on the north side of Loomis Lab, between rooms 267 and 271 LLP) on the day of the due date. Unless a valid, verifyable excuse is given, homework sets which are submitted late will receive a 50% penalty. Homework sets which are turned in more then a week late will receive no credit. Questions about the grading of a homework must be addressed within two weeks of receiving the assignment back. The homework counts for a large part of your grade (45%) and will be difficult. You will learn quantum mechanics by doing problems! You may discuss the homework problems with your classmates, but each student is required to provide his/her own solutions. You may not look up solutions to the homework on the internet. Grading policies Your grade will be based on homework (45%) the midterm exam (20%) the final exam (25%) and attending discussion sections (10%) If you cannot attend a class or complete your homework due to illness or other valid excuse, please give the McKinley slip (or other note) to Kate Shunk in the Undergraduate Courses office (233 Loomis). Academic Honesty The giving of assistance to or receiving of assistance from another person, or the use of unauthorized materials during University Examinations can be grounds for disciplinary action, up to and including expulsion from the University. You may not use the internet to find solutions to problems you are working. Course Texts The following are the required/recommended course texts: Introduction to Quantum Mechanics, 2nd Edition, D. J. Griffiths (REQUIRED) Principles of Quantum Mechanics, 2nd Edition, R. Shankar (RECOMMENDED) Other books I highly recommend reading: A Modern Approach to Quantum Mechanics by John S. Townsend; Lectures on Quantum Mechanics by Gordon Baym Quantum Mechanics Volumes I and II by Cohen-Tannoudji; Very comprehensive - use as a reference Quantum Computation and Quantum Information by Nielsen and Chuang; Mainly a text on quantum computing, but Chapter 2 has a very clear exposition on quantum mechanics. Feynman Lectures on Physics: v. 3 by Richard Feyman; Additional books on reserve in the library: Quantum Mechanics by Landau and Lifshitz Quantum Physics: Of Atoms, Molecules, Solids, Nuclei, and Particles, 2nd Edition by Eisberg/Resnick Heisenberg's Quantum Mechanics by Mohsen Razavy Quantum Mechanics: An Introduction for Device Physicists and Electrical Engineers by David K. Ferry Course Schedule This should be treated as tentative and will change. Please check the website: frequently for updates. Notice, we will not be following any one book closely. Week Date Lecture Discussion Homework Reading 1 08/26 What specifies a quantum state? Lecnotes1 Dis1 Solutions: Problem 1 Problem 2 HW1 (due 09/03) corrected of typos HW1 Solution Griffiths 3.6; Shankar 1.1 and 1.3.1; Baym Chapter 1; 08/28 Measurement and Expectation Lecnotes2 Shankar 4.1, 4.2, (- pg 128); Griffiths 1.2, 1.3, 3.2; 2 09/02 Time Evolution + Stationary States Lecnotes3 Dis2: p1, p2 Solution: p1 p2 HW2 (due 09/11) HW2 Solution Shankar 1.8, 1.10; Cohen-Tannoudi ch 3; Baym Ch. 14; Griffiths 2.1, 2.2; 09/04 Stern-Gerlach experiment + operators Lecnotes4 Feynman 5.1; Shankar 9.x; Cohrn-Tannoudi 4.A; Griffths 3.5 3 09/09 Schrodinger's Equation Lecnotes5 Lecture notes from previous version of course on solving particle in a box: Extra Lecnotes Dis3 Solutions: For problem 1, see Griffths 2.6 Problem 2 Solution HW3 (due 09/18) HW3 Solution Shankar 4.3, 5.2; Baym Ch. 4; Griffiths 1.1, 2.1 09/11 Solving the Schrodinger Equation Lecnotes6 Shankar 1.8; Griffiths 3.3 4 09/16 The Density Matrix and Finite Temperature Lecnotes7 Dis4 Solution HW4 (due 09/25) HW4 Solution Shankar 133-141; Baym Ch1, problems 17,18; Neilsen and Chaung 2.4; Cohen-Tannoudi EIII 09/18 Two Particles/Spins Lecnotes8 Shankar Ch 10; Cohen-Tannoudi DIV; Griffiths Ch 5; 5 09/23 The simple harmonic oscillator: real space Lecnotes9 Lecture notes from previous version of course on solving SHO Dis5 (problem in solutions) Solution HW5 (due 10/02) HW5 Solution Griffiths: 2.3; Shankar: Ch. 7 (-202) 09/25 The simple harmonic oscillator: operator expansion Lecnotes10 Griffiths: 2.3; Shankar: Ch. 7 (-202) 6 09/30 More Simple Harmonic Oscillator Lecnotes11 Dis6 Solution HW6 (due 10/09) HW6 Solution Griffiths: 2.3; Shankar: Ch. 7 (-202) 10/02 Path Integrals I Lecnotes12 Shankar Chapter: The Path Integral Formulation of Quantum Theory; Baym pg 69-79; Also here 7 10/07 Path Integrals II Lecnotes13 Dis7 Solution HW7 (due 10/17) HW7 Solution Chapter 1 of Quantum Mechanics and Experience by David Z. Albert 10/09 Path Integrals III Lecnotes14 Shankar Chapter: The Path Integral Formulation of Quantum Theory; Baym pg 69-79; Also here 8 10/14 Summary + Questions Dis8a Dis8b HW8 (due 10/23) HW8 Solution 10/16 Midterm Exam midterm 9 10/21 Quantum Mechanics in higher dimensions Lecture notes from previous version of course Lecnotes16 Dis9 Solution HW 9 (due 10/30) HW9 Solution Shankar Chapter: Rotational Invariance and Angular Momentum + Symmetries and their consequences; Griffiths Chaper: Quantum Mechanics in three dimensions. 10/23 Angular Momentum I Lecnotes17 Shankar Chapter: Rotational Invariance and Angular Momentum + Symmetries and their consequences; Griffiths Chaper: Quantum Mechanics in three dimensions. 10 10/28 Angular Momentum II Lecnotes18 Dis10a Dis10b Solution a Solution b HW 10 (due 11/06) HW10 Solution Shankar Chapter: Rotational Invariance and Angular Momentum + Symmetries and their consequences + The Hydrogen Atom; Griffiths Chaper: Quantum Mechanics in three dimensions. 10/30 The coulomb potential Lecnotes19 Shankar Chapter: Rotational Invariance and Angular Momentum + Symmetries and their consequences + The Hydrogen Atom; Griffiths Chaper: Quantum Mechanics in three dimensions 11 11/04 Beyond the Hydrogen Atom Lecnotes20 Dis11 Solution HW11 (due 11/13) HW11sol Shankar Chapter: 13.4; Griffiths Chaper: Quantum Mechanics in three dimensions. 11/06 Identical Particles + Intro to Quantum Computing Lecnotes21 Shankar Chapter: 10; Griffiths Chaper: Chapter 5 12 11/11 Shor's Algorithm Lecnotes22 Dis12 Solution HW12 (due 11/20) HW12sol See John Preksill's notes: - 6.9 - 6.11 11/13 Grovers' Algorithm Lecnotes23 See John Preksill's notes: - 6.8 13 11/18 A brief overview of QEC and Adiabatic Quantum Computing Lecnotes24 Dis13 Solution HW13 (due 12/04) HW13sol See John Preksill's notes: for quantum error correction; Chapter 10 of Griffiths for adiabatic theorem 11/20 Approximations: The Variational Approach Lecnotes25 Chapter 7 of Griffiths; Chapter 16 of Shankar 14 12/02 The Variational Approach Continued Lecnotes26 Dis14 HW14 (due 12/10) HW14sol Chapter 7 of Griffiths; Chapter 16 of Shankar 12/04 Slater-Jastrow + Beyond the Variational Principle Lecnotes27 15 12/09 Questions Lecnotes28 No HW 12/11 No class

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