Physics 341: Quantum Mechanics Syllabus

Fall 2014

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Office Hours: Monday 10-12
Tuesday 9-10
Wednesday 10-11
Thursday 10-11

Text: Introduction to Quantum Mechanics by David J. Griffiths, ISBN# 0131118927
DO THE ASSIGNED READINGS PRIOR TO CLASS- this will allow you to become familiar with the terms and topics and have questions about the material prepared before lecture

Course Description:
Wave packets, Schrödinger's equation, square-well and barrier potentials, the harmonic oscillator, the hydrogen atom, atomic spectra, multi-electron atoms, algebraic methods, matrix mechanics, perturbation theory. Prerequisites: Physics 222 and Mathematics 221 or permission of instructor.

Course Goals:
The main goal for this course is for students to develop an understanding of probabilistic nature of quantum mechanics and to apply these ideas to various quantum mechanical processes and systems. Students will use the Schrödinger equation, matrix and algebraic techniques to solve standard problems of quantum mechanics. Understanding the nature of a quantum mechanical measurement and the interpretation of the quantum mechanics will be cultivated and influence students appreciation of how quantum mechanics has shaped our understanding of the physical world. Students will also experience a wide variety of experiments throughout the course, connecting the practical elements to the conceptual and mathematical material of the covered.

Grading:
Your letter grade is determined by a minimum weighted average which is as follows: A/93, A-/90, B+/87, B/83, B-/80, C+/77, C/73, C-/70, D+/67, D/63, D-/60, F/0. The breakdown of the grading will be as follows:

Exam 1	10%
Exam 2	10%
Exam 3	10%
Homework	25%
Research Paper	15%
Research Poster	15%
Research Presentation	15%

Course Materials:
All course materials will be made available on blackboard. These materials include this syllabus, laboratory procedures, and any solutions I may provide.

Exams:
There will be three exams during the semester. Each will be 50 minutes long. Exams will include problem solving questions, but there may also be conceptually based questions to be answered with words.

Homework:
Homework assignments comprise a large percentage of your final grade, the due dates of which are listed on the schedule given in this syllabus. These assignments may not be thoroughly reviewed in class and will be graded outside of class by the instructor. Please feel free to ask questions about the homework and to consult other sources, however the final assignment that is submitted must be your own work. Homework is very important. There is a strong correlation between completing the homework assignments and doing well on exams and in the course as a whole.

Lab Projects:
Each student will select three labs. The selected labs **CANNOT** be one of the labs completed for PHYS222. There is usually only one set up for each lab so it will be important to schedule times to work on labs with your classmates. There will be three major projects comprising the lab grade; a formal lab paper, a poster and a 20 minute presentation. In lieu of a final exam and lab grade, each project will count for **15%** of your total grade. A synopsis of each project and the due dates for the drafts and final copies of these projects are given in this syllabus. The drafts are very important to keeping your work on track and are worth up to **10%** of a total project grade. Students will be required to attend the talks presented by other students and prepare a half page response to each other students' presentations and posters, which will contribute to your grade on the final project.

Attendance:
Attendance is mandatory. If you cannot attend class for any reason, it is your responsibility to contact me with the reason for your absence and to obtain any material you missed. An absence will be considered excused and not count against you if it is due to reasons such as illness, death in the family, etc. **Missed exams and assignment deadlines will only be excused in the event of excused absences, in which case another time can be scheduled to take the exam or turn in an assignment.**

Important Notes:
Education is all about open communication. My responsibility is to communicate information and problem solving techniques to you. However, communication works both ways. You must also communicate to me if are having trouble with or questions about any material. Your questions are always welcome. I do not know what you do not know. The explanations and examples I give make perfect sense to me, but you may need further clarification. To that end, please feel free to email me or attend my office hours with any questions you may have. If you cannot attend any of the available office hours, please email me and we can schedule another time to meet.

Disabilities and Medical Conditions:
Moravian College adheres to the principles and mandates of the Americans with Disabilities Act of 1990 and the Rehabilitation Act of 1973. Students who wish to request accommodations in this class for a disability should contact Elaine Mara, assistant director of learning services for academic and disability support located on the first floor of Mononcacy Hall, or by calling 610-861-1401. Accommodations cannot be provided until authorization is received from the Academic Support Center.

Special classroom set-ups, alternate testing, physical plant (campus) alterations, and other accommodations for students with documented disabilities are available on a case-by-case basis. It is the responsibility of students with disabilities to self-identify and request accommodation through the appropriate office.

It is the responsibility of the student to request accommodation well in advance of the need in order to give the College a reasonable amount of time to evaluate the documentation and implement the request. Classroom accommodation requiring notification to faculty must be requested for each semester for which it is needed.

Please see Disability Support Services in the Campus Offices and Services section elsewhere in the Moravian College Student Handbook for further information, and check the College's website for periodic updates concerning services for students with disabilities.

Academic Honesty Statement:
Academic integrity is the foundation on which learning at Moravian College, Moravian Theological Seminary, and the Comenius Center is built. Students are expected to perform their academic work honestly and fairly. In addition, students should neither hinder nor unfairly assist the efforts of other students to complete their work.

In an academic community, students are encouraged to help one another learn. Because no two students learn in exactly the same way or absorb exactly the same things from a lecture, students are encouraged to study together. The boundaries on what is or is not acceptable work may not always be clear; thus, if at any point in academic work at Moravian, students are uncertain about their responsibility as scholars or about the propriety of a particular action, please see Academic Honesty in the Academic Life section elsewhere in the Moravian College Student Handbook for further information, and check the College's website for periodic updates.

Class Schedule

Date	Topic	Reading before class	HW	Due in Lab
8/25	Introduction to the wave function			
8/27	The Schrödinger Equation	1.1-1.3		
8/29	Statistical Interpretation	1.4-1.6		Select/ Assign Labs
9/1	Statistical Interpretation		HW 1	
9/3	Time Independent Schrödinger Equation	2.1-2.3		
9/5	Infinite Square Well			Paper Summary (9/4)
9/8	Infinite Square Well		HW 2	
9/10	Harmonic Oscillator			
9/12	Harmonic Oscillator			Paper Data (9/11)
9/15	Free Particle	2.4-2.6	HW 3	
9/17	Delta Function Potential			
9/19	Finite Square Well			Paper Draft (9/18)
9/22	Scattering Matrix		HW 4	
9/24	WKB Approximation	8.1-8.3		
9/26	Bouncing Ball and Tunneling			Conference (9/25)
9/29	Linear Algebra and Observables	3.1-3.3, A.6	HW 5	
10/1	Hermitian Transformations			
10/3	**EXAM 1**	**CH 1, 2, 8**		**Paper Final (10/2)**
10/6	Uncertainty Principle	3.4-3.6	HW 6	
10/8	Dirac Notation			
10/10	Quantum Mechanics in Three Dimensions	4.1-4.2		Poster Summary (10/9)
10/13	FALL BREAK			
10/15	Schrödinger Equation in Spherical Coordinates			
10/17	Hydrogen Atom	4.3-4.4		Poster Data (10/14)
10/20	Hydrogen Atom		HW 7	
10/22	Angular Momentum and Spin			
10/24	Time-Independent Perturbation	6.1-6.2		Poster Draft (10/21)
10/27	Zeeman Effect	6.3-6.4	HW 8	
10/29	Hyperfine Splitting	6.5		
10/31	Variational Principle	7.1-7.2		Conference (10/28)
11/3	Ground State of Helium	7.3	HW 9	
11/5	Time-Dependent Perturbation Theory	9.1-9.2		
11/7	**EXAM 2**	**CH 3, A.6, 4, 6**		**Poster Final (11/6)**
11/10	Adiabatic Approximation	10.1-10.2		
11/12	Adiabatic Approximation		HW 10	
11/14	Scattering	11.1-11.2		Talk Summary (11/13)
11/17	Phase Shifts	11.3-11.4		
11/19	The Born Approximation			
11/21	Catch up/ Review		HW 11	Talk Data (11/20)
11/24	**EXAM 3**	**CH 7, 9, 10, 11**		
11/26	THANKSGIVING BREAK			
11/28	THANKSGIVING BREAK			
12/1	Presentations			
12/3	Presentations			
12/5	Presentations			

Formal Lab Report Paper

The goal of this project is to familiarize you with writing a scientific paper. Each paper should include abstract, introduction, methodology, results, conclusion and references sections. The methodology section is essentially the body of the paper and is the most open-ended section. The mathematics used to explain what is being studied should be addressed in this section as well as the experimental method. This is also where you must demonstrate the connection between theory and measurement. How the measured values relate to the equations presented is VERY IMPORTANT. This is also where any assumptions or approximations should be discussed. A rubric will be distributed giving specific requirements for each section.

The materials due on the dates listed on the schedule are described below.

SUMMARY: The summary that is due is essentially your introduction and methodology sections. The introduction should include all of the background necessary to understand your experiment and its significance within the field of physics. The methodology section should explain the basics mathematics, the experimental procedure, and the connection between the two.

DATA: At this point you should have collected all the data for this lab. The data should be presented in an organized table. You should also have analyzed the data. How you do so will depend on the specific lab, but in general a plot of the data and description of any identifiable trends. THIS DOES NOT GAURENTEE YOU ARE DONE TAKNIG DATA. Once you have submitted your data, we will review it together and determine that additional data are needed to confirm or strengthen a hypothesis, investigate additional variables, etc.

DRAFT: The full draft is due two weeks before the final paper. This will allow time for me to edit your draft, for us to conference and discuss any changes that need to be made, and for you to work on the final copy.

CONFERENCE: The conference will be used to discuss your draft and any changes that should be made before the submission of your final paper. The conference may occur any time after the draft due date (providing time for editing) and the conference due date. We will schedule times during lab period.

Poster

The goal of this project is to familiarize you with creating a scientific poster. Posters are very different from papers. You do not necessarily have a captive audience, and the poster must be concise and clear enough to attract readers at first glance. A poster that is too busy is intimidating. The less you can say with words and the more you can say with figures, the better. The figures on a poster should be very simple for several reasons. People viewing your poster may not be experts in your field, so the point must be immediately clear to them. Additionally, readers should be able to glean the basic results of your experiment from one graph. Each poster should include abstract, introduction, theoretical model, experimental method, results, conclusion and references sections. Particular emphasis will be given to making clear figures that demonstrate the results of the experiment. A rubric will be distributed giving specific requirements for each section.

The materials due on the dates listed on the schedule are described below.

SUMMARY: The summary that is due is essentially your introduction, theoretical model, and experimental setup sections, including any figures needed for these sections. The introduction should include all of the background necessary to understand your experiment and its significance within the field of physics. The theoretical model section should explain the basics mathematics and how these equations relate to the experiment. The experimental method should include the experimental setup, the experimental procedure, and the connection between the two.

DATA: At this point you should have collected all the data for this lab. The data should be presented in an organized table. You should also have analyzed the data. How you do so will depend on the specific lab, but in general a plot of the data and description of any identifiable trends. THIS DOES NOT GAURENTEE YOU ARE DONE TAKNIG DATA. Once you have submitted your data, we will review it together and determine that additional data are needed to confirm or strengthen a hypothesis, investigate additional variables, etc.

DRAFT: The full draft is due two weeks before the final poster. This will allow time for me to edit your draft, for us to conference and discuss any changes that need to be made, and for you to work on the final copy.

CONFERENCE: The conference will be used to discuss your draft and any changes that should be made before the submission of your final poster. The conference may occur any time after the draft due date (providing time for editing) and the conference due date. We will schedule times during lab period.

Presentation

The presentation given must be 18 minutes ±2 minutes, with two minutes allowed for questions. Your presentation must include a powerpoint-esque slides. A hard copy of the slides should be distributed before your talk so that viewers can make notes and reference specific slides during the questions session. Your grade for the presentation will also include your participation in a 10 point evaluation of the other presentations. You will be provided a copy of the evaluation prior to the presentations. The most important aspect of your presentation is that it is clear and easily understood by your audience. Even points that may be obvious to you must be explicitly explained to someone who is not as familiar with the material. For example, when giving a presentation it is imperative that you always explain the axis of your figures. You may be very used to looking at a graph of intensity vs. frequency, but without an explanation of what is shown, your audience will be distracted while trying to read the labels of the graph and miss your explanation the features of interest. The most important aspect of a talk is preparation. Clear, understandable slides and a practiced talk will make the best impression and give you the confidence to speak intelligently about your experiment and answer the audience's questions. A rubric will be distributed giving specific requirements for each section.

The materials due on the dates listed on the schedule are described below.

SUMMARY: The summary that is due is a thorough outline of the introduction, theoretical portion and experimental setup and procedure portions of your talk written, and the presentation slides for these sections.

DATA: This is a very important meeting. The week following this meeting is thanksgiving break, so you must have **ALL** your final data taken before going on break. At this meeting you should have your results fully prepared and analyzed so that we can determine if you need to take more data before the break. Bring your slides and all your graphs and figures.