PHYS 526 01W – THE QUANTUM UNIVERSE FOR EDUCATORS

ONLINE COURSE SYLLABUS: SPRING 2023

Instructor: Dr. William Newton, Associate Professor
Office Location: STC 236
University Email Address: William.Newton@tamuc.edu
Course Dates: Jan 17 – May 13
Course Time Zone: Central Time USA
Online Office Hours I will schedule time once or twice a week, depending on people's availability, you can join me on Zoom to discuss/answer questions. I will try and schedule one during a weekday evening and one at a weekend. You will complete a poll during the first week to determine the best times.

Emails In emails, please put "PHYS526 Online" in the subject header. I will reply to emails within 24 hours (48 at weekends and holidays). ***Note:*** *I will exclusively use your TAMUC university email addresses for email communication.*

COURSE INFORMATION

Materials – Textbooks, Readings, Supplementary Readings

The 2 required books can be ordered from online retailers for a total of around $100 or under.

Textbooks Required

McIntyre, D. (2012), *Quantum Mechanics: A Paradigms Approach,* Addison-Wesley, ISBN-10: 0321765796, ISBN-13: 978-0321765796

Recommended

Orzel, C. (2010), *How to Teach Quantum Physics to Your Dog,* Oneworld Publications, ISBN-10: 1851687793, ISBN-13: 978-1851687794

Course Prerequisites

Math: Students are required to know mathematics through Calculus 3 or equivalent, or have taken or be concurrently taking the Mathematical Methods for Educators Course (PHYS 530). ***This course makes extensive use of linear algebra, (especially matrix algebra) and complex numbers.*** We will need some differentiation and integration, and the Schrodinger equation, which plays a central role in quantum mechanics, is a second-order differential equation.

Physics: A course in calculus-based physics is required. Some knowledge of basic thermodynamics and statistical mechanics will be an advantage, but I will explain concepts from those subjects when we need to use them.

Course Description

The history of quantum mechanics including the experimental results that required a new theory of the interaction between light and matter at microscopic level. The uncertainty principle, wave-particle duality and wave mechanics. Applications (including simple calculations) to atomic physics, nuclear physics, semiconductors, lasers; how quantum mechanics has shaped the modern world. The impact of quantum mechanics in our culture; its uses and misuses. Prerequisites: University physics and calculus up to partial differential equations (*2015 TAMUC Graduate Catalog).*

Quantum theories underpin our modern world. Without quantum mechanics, modern electronic devices such as computers, cell phones, most modern medical imaging and technology, most development in materials science, the World Wide Web, and many other things would not exist. It is the most accurately tested physical theory that exists - giving numerical predictions verified by experiments to more decimal places than our theories of gravity, Newton's laws of motion or our laws of thermodynamics.

Quantum mechanics is also most misunderstood and abused scientific theory. Misunderstanding is not surprising. Quantum mechanics makes claims on the nature of reality at the microscopic level running counter to our everyday experience. Some principles of quantum mechanics have made it into popular culture in a distorted way; for example the, notion reality can be affected by the observer. These vague notions are exploited by those who wish to peddle all manner of pseudoscience. It is therefore very important to understand how to interpret quantum mechanics.

In this class, we will learn about the fascinating history of the development of quantum mechanics, the fundamental principles of the theory and the practical and fundamental physics applications, develop lesson plans introducing the exciting physics of quantum theory to high school students, and explain the ways in which the theory can be misunderstood and misused.

The purpose of this class is three-fold:

1) To give you a working knowledge of the fundamentals of quantum mechanics and its modern applications. To appreciate how it has created the modern world, and that it is the most precisely tested scientific theory.

2) To explore the history and interpretation of quantum theory as an archetype of a scientific revolution, in order understand better how scientific theories develop.

3) To discuss the teaching of these at a high school level, examine common misconceptions, explore the many tools available on the web that aid us, and to share experiences and resources as a community.

Student Learning Outcomes

At the end of the course students will:

1. Demonstrate knowledge of the history of quantum mechanics, and argue why it is an exemplar of a scientific revolution.

2. Explain the conceptual principles of quantum mechanics, express them mathematically, and apply them to make quantitative predictions in fundamental and applied physical situations.

3. Display knowledge of the research literature on student learning and understanding of quantum mechanics.

COURSE REQUIREMENTS

Instructional Methods / Activities / Assessments

The details of the course structure are given below. Any changes will be communicated via email and announcements on MyLeo Online. Your TAMUC email account will be used at all times, and it will be your responsibility to check it regularly (at least once every 24 hours).

Course structure

The course is divided up into 4 units, each containing 3 weeks. Although I refer to them as weeks, some of them span two weeks worth of time. If in doubt, consult the class schedules at the end of the syllabus. Each unit covers a major step in the historical development of quantum mechanics or a major topic. At the end of each unit will be a "catch-up" week to draw breath, complete tutorial homeworks and assessments, and take stock before the next major topic.

Each week's material becomes available at **12.01 a.m.** on a Friday. Although each week has its associated assignments, I will also make all reading and tutorials/tutorial homeworks available in a separate module from the start of the semester.

Each week you will watch 1-4 mini-lectures, do selected readings from the textbook and complete the various assignments listed below.

The first half of the semester involves an in-depth look at the historical development of quantum mechanics. Most of the reading assignments are during this half, although a number of problem sets will get your math skills up to speed and introduce you to Dirac notation for the second half.

The second half of the semester develops the theory mathematically.

Introductory tasks

The semester starts at **12.01 a.m. Tuesday, January 17th** which is when the introductory material and unit 1 will become available.

Before tackling Unit 1 and the rest of the course, you must complete the following activities which you can find in the introductory module:

(1) Read the **syllabus**
(2) Take the **syllabus quiz** to make sure you understand the mechanics of the course. This can be taken *any number of times*. The **syllabus quiz** will not be graded, but it must be completed *with 100% correct answers* before moving on to unit 1.
(3) **Introduce** yourself to the class on the **"Class Introductions"** discussion thread.
(4) Create your account on **Perusall** (link given in email and D2L).
(5) Complete the availability survey to set Zoom office hours (link given in email and on D2L).

NOTE: You must complete the syllabus quiz with 100% correct answers before access the first, and subsequent, units.

Learning Activities and Assessments

The following describes the assignments you must complete which will contribute to your progress through the course and to your final grade, together with how they will be assessed. There are strong similarities with assessments in other classes in the program, but also some important differences in the details.

Perusall assignments: Perusall is an online system that enables students and instructors to collectively discuss a text as they read. We will be using Perusall for reading assignments and to work collaboratively on tutorials. See schedule at the end of the syllabus and in Perusall itself for the schedule of assignments. You make annotations (notes) as you read to share your thoughts, write questions, and collaborate on discussing and answering tutorial questions. You can respond to each other and upvote each other. Like the discussion forums, I will also contribute.

Submitting non-Perusall assignments: Homework that involves problem solving, pictures, or other material that is difficult to submit as a Word format or similar, may be submitted as hand written work scanned in or photographed. If you use a camera phone to take pictures of your work, a useful app is CamScanner (https://www.camscanner.com), which compiles multiple pictures into one document for ease of uploading. There is a free version that I encourage you to check out. It is your responsibility to make sure that your work is legible. You will upload your assignment to D2L under the relevant assignment. Do NOT upload multiple jpg or pdf files – make sure each assignment is a single file.

- **Quizzes** are designed to assess students' comprehension of the reading assignments, mini-lectures and basic knowledge of key principles, often in response to the mini-lectures and reading assignments.

  Quizzes are designed to provide you with assessment of your learning. Half of the quiz grade will be awarded just for completing the quiz; the other half will come from your actual quiz score.

  You will only be able to take quizzes once. Once you begin taking the quiz, you will have a time limit of one hour to complete it. Once completed, you cannot return to it and revise your answers. You will see your score, however, and what answers you got wrong.

- **Ongoing Discussions** will be conducted each week on the concepts introduced in the reading material and lectures. A number of threads will be opened on particular topics. Sometimes I will ask a question or pose a problem to get you started.

  Learning and understanding is significantly enhanced by active engagement in the class through continual discussion of topics. All students are required to participate in the discussions with a number of substantive posts. **Students are required to make 2 substantive posts, in three separate threads, giving your thoughts about the reading or answering the opening questions. In addition, students are required to make one post in the *previous* week's threads, replying to posts of other students or of myself. That makes a total of 3 posts per week that will be graded.**

  Of course, continued discussion beyond the minimum posts required is strongly encouraged. I will pitch into the discussion at various times during the week, answering queries and asking new questions to make sure we discuss all the week's material adequately.

  When appropriate, at least one thread will be devoted to discussing how one might teach the week's concepts at the undergraduate level, and for the sharing of your own experiences and resources for the benefit of the teaching community. I hope to make the discussion threads a fun and lively forum throughout the semester!

- **Reading assignments (on Perusall)**
  There will be 9 reading assignments. 6 of these will be original papers from the development of quantum mechanics from Planck, Einstein, Bohr and others. These are sometimes accompanied by a paper

analyzing their work. Later in the semester, there will be research papers on how students learn specific concepts in quantum mechanics. I can see how much of the paper you have read and how much time you have spent reading. I will introduce the reading with some prompts to set the discussion going.

- **Tutorials (on Perusall)**
  Tutorials are designed to take students step-by-step through a topic with the aim of learning the concepts at a deep level. 8 tutorials will be assigned throughout the semester. You should work through the tutorials on your own. ***Do not ues Perusall to write in all your answers.*** Perusall will be used to collaborate by you asking questions, offering potential solutions and constructively analyzing and assessing each others work, building on each others thoughts to reach a complete understanding. You will often need to use math in your comments on Perusall. There are two ways to do it. Perusall supports LaTeX, the document markup language, which makes it easy to write equations seamlessly in the text. Many of you will not be familiar, so I will offer some tips to get your started. I encourage you to try it! The other option, which is also fine, is to upload pictures of written equations, or snapshots of equations prepared in equation editor in Word, for example.

- **Homeworks and Assessments**
  - **Homeworks:** in the first unit, you will complete a number of problem sheets covering the basic mathematics required understand the formal presentation of the theory coming up in the second half of the semester. After then, there will be two homeworks in units 3 and 4 respectively involving textbook problems.
  - **Assessments:** These are longer worksheets/problem sheets which either follow up a tutorial (in the case of the first one) or apply the learning of a whole unit to a physical situation (such as quantum encryption in unit 3 and Lamor precession of atoms in unit 4).

  These are not on Perusall. You can discuss problems that arise in the appropriate discussion threads.

When to complete assignments: Quizzes and discussion posts are due at the end of each of the 12 weeks. Perusall assignments are due one week later. Your comments and annotations on reading assignments and tutorials are due at the end of the week they are assigned. These are not assigned uniformly – some weeks will have no reading assignments, and some no tutorials; some will have more than one reading. Homeworks and assessments are due at the end of each unit, in four batches. At the end of the syllabus you will find the precise dates for every single assignment of every type!

Try to keep to these deadlines. However, I know your lives are tremendously busy and there will be times when you are overwhelmed. I will always be flexible with due dates if you just give me a heads up when you need to be.

Grading

We will use specifications-based grading in this course, in which, rather than assigning numerical scores to each assignment (which, although prevalent, are hard to standardize fairly), you simply receive a passing credit for completing an assignment to an acceptable standard, which will be specified with each assignment. Anyone who makes a good-faith attempt at all assignments will earn at least a B in the class.

For each assignment you either pass or you do not.
Quizzes: You pass a quiz by making more than 70%.
Discussion posts: A passing grade for a week's discussion forums requires making all required posts, and each post to be substantial in the sense that it contributes constructively to the conversation (which includes asking questions so long as they include context, justification, and details of what the poster has done to try and answer them).
Perusall assignments (Reading and tutorials): The system automatically calculates a percentage grade based on number and quality of annotations, interacting with each other, and time spent reading. I have set a threshold for passing.
Homeworks: A good faith attempt has been made, that is, the student has completed all of it, gets the right answer more often than not, and thoroughly explains their thoughts and makes clear their working.
Assessments: The student scores more than 70% on the assessment.

If at any point you do not feel the grade fairly reflects your performance, please let me know.

Your final grade will be assigned based on the following scheme:

You will get a A if you:

Meet all the requirements of getting a B, but in addition:
Pass 5 out of 5 homeworks
Get an average of 90% or more on the three assessments.

You will get a B if you:

Pass 8 out of 9 Perusall reading assignments
Pass 6 out of 8 Perusall tutorial assignments
Pass 4 out of 5 homeworks
Pass 10 out of 12 quizzes
Meet the requirements in 10 out of 12 discussion forums
Get an average of 70% or more on the three assessments.

You will get a C if you:

Pass 6 out of 9 Perusall reading assignments
Pass 5 out of 8 Perusall tutorial assignments
Pass 3 out of 5 homeworks
Pass 8 out of 12 quizzes
Meet the requirements in 8 out of 12 discussion forums
Get 70% or more on at least one assessment.

You will get a D if you:

Pass 5 out of 9 Perusall reading assignments
Pass 4 out of 8 Perusall tutorial assignments
Pass 2 out of 5 homeworks
Pass 6 out of 12 quizzes
Meet the requirements in 6 out of 12 discussion forums
Get 60% or more on at least one assessment.

TECHNOLOGY REQUIREMENTS

Browser support

D2L is committed to performing key application testing when new browser versions are released. New and updated functionality is also tested against the latest version of supported browsers. However, due to the frequency of some browser releases, D2L cannot guarantee that each browser version will perform as expected. If you encounter any issues with any of the browser versions listed in the tables below, contact D2L Support, who will determine the best course of action for resolution. Reported issues are prioritized by supported browsers and then maintenance browsers.

Supported browsers are the latest or most recent browser versions that are tested against new versions of D2L products. Customers can report problems and receive support for issues. For an optimal experience, D2L recommends using supported browsers with D2L products.

Maintenance browsers are older browser versions that are not tested extensively against new versions of D2L products. Customers can still report problems and receive support for critical issues; however, D2L does not guarantee all issues will be addressed. A maintenance browser becomes officially unsupported after one year.

Note the following:

- Ensure that your browser has JavaScript and Cookies enabled.
- For desktop systems, you must have Adobe Flash Player 10.1 or greater.
- The Brightspace Support features are now optimized for production environments when using the Google Chrome browser, Apple Safari browser, Microsoft Edge browser, Microsoft Internet Explorer browser, and Mozilla Firefox browsers.

Desktop Support

Browser	Supported Browser Version(s)	Maintenance Browser Version(s)
Microsoft® Edge	Latest	N/A
Microsoft® Internet Explorer®	N/A	11
Mozilla® Firefox®	Latest, ESR	N/A
Google® Chrome™	Latest	N/A
Apple® Safari®	Latest	N/A

Tablet and Mobile Support

Device	Operating System	Browser	Supported Browser Version(s)
Android™	Android 4.4+	Chrome	Latest
Apple	iOS®	Safari, Chrome	The current major version of iOS (the latest minor or **point** release of that major version) and the previous major version of iOS (the latest minor or **point** release of that major version). For example, as of June 7, 2017, D2Lsupports iOS 10.3.2 and iOS 9.3.5, but not iOS 10.2.1, 9.0.2, or any other version. Chrome: Latest version for the

Device	Operating System	Browser	Supported Browser Version(s)
			iOS browser.
Windows	Windows 10	Edge, Chrome, Firefox	Latest of all browsers, and Firefox ESR.

- You will need regular access to a computer with a broadband Internet connection. The minimum computer requirements are:
    - 512 MB of RAM, 1 GB or more preferred
    - Broadband connection required courses are heavily video intensive
    - Video display capable of high-color 16-bit display 1024 x 768 or higher resolution

- You must have a:
    - Sound card, which is usually integrated into your desktop or laptop computer
    - Speakers or headphones.
    - *For courses utilizing video-conferencing tools and/or an online proctoring solution, a webcam and microphone are required.

- Both versions of Java (32 bit and 64 bit) must be installed and up to date on your machine. At a minimum Java 7, update 51, is required to support the learning management system. The most current version of Java can be downloaded at: JAVA web site http://www.java.com/en/download/manual.jsp

- Current anti-virus software must be installed and kept up to date.

Running the browser check will ensure your internet browser is supported.
Pop-ups are allowed.
JavaScript is enabled.
Cookies are enabled.

- You will need some additional free software (plug-ins) for enhanced web browsing. Ensure that you download the free versions of the following software:
    - Adobe Reader https://get.adobe.com/reader/
    - Adobe Flash Player *(version 17 or later)* https://get.adobe.com/flashplayer/
    - Adobe Shockwave Player https://get.adobe.com/shockwave/
    - Apple Quick Time http://www.apple.com/quicktime/download/

- At a minimum, you must have Microsoft Office 2013, 2010, 2007 or Open Office. Microsoft Office is the standard office productivity software utilized by faculty, students, and staff. Microsoft Word is the standard word processing software, Microsoft Excel is the standard spreadsheet software, and Microsoft PowerPoint is the standard presentation software. Copying and pasting, along with attaching/uploading documents for assignment submission, will also be required.

If you do not have Microsoft Office, you can check with the bookstore to see if they have any student copies.

ACCESS AND NAVIGATION

You will need your campus-wide ID (CWID) and password to log into the course. If you do not know your CWID or have forgotten your password, contact the Center for IT Excellence (CITE) at 903.468.6000 or helpdesk@tamuc.edu**.**

Note: Personal computer and internet connection problems do not excuse the requirement to complete all course work in a timely and satisfactory manner. Each student needs to have a backup method to deal with these inevitable problems. These methods might include the availability of a backup PC at home or work, the temporary use of a computer at a friend's home, the local library, office service companies, Starbucks, a TAMUC campus open computer lab, etc.

COMMUNICATION AND SUPPORT

Brightspace Support

Student Support

If you have any questions or are having difficulties with the course material, please contact your Instructor.

Technical Support

If you are having technical difficulty with any part of Brightspace, please contact Brightspace Technical Support at 1-877-325-7778 or click on the **Live Chat** or click on the words "click here" to submit an issue via email.

System Maintenance

D2L runs monthly updates during the last week of the month, usually on Wednesday. The system should remain up during this time unless otherwise specified in an announcement. You may experience minimal impacts to performance and/or look and feel of the environment.

We will use Zoom for the live office hours; I will email a link ahead of each office hours. Note: It is not required that you attend live office hours.

COURSE AND UNIVERSITY PROCEDURES/POLICIES

Course Specific Procedures

Academic Honesty

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including (but not limited to) receiving a failing grade on the assignment, the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. In **ALL** instances, incidents of academic dishonesty will be reported to the Department Head. Please be aware academic dishonesty includes (but is not limited to) cheating, plagiarism, and collusion.

Cheating is defined as:

- Copying another's test of assignment.
- Communication with another during an exam or assignment (i.e. written, oral or otherwise).
- Giving or seeking aid from another when not permitted by the instructor.
- Possessing or using unauthorized materials during the test.
- Buying, using, stealing, transporting, or soliciting a test, draft of a test, or answer key.

Plagiarism is defined as:

- Using someone else's work in your assignment without appropriate acknowledgement.
- Making slight variations in the language and then failing to give credit to the source.

Collusion is defined as:

- Collaborating with another, without authorization, when preparing an assignment.

If you have any questions regarding academic dishonesty, ask. Otherwise, I will assume that you have full knowledge of the academic dishonesty policy and agree to the conditions as set forth in this syllabus. **Homework and discussion posts will be randomly tested for plagiarism.**

Attendance Policy

In an online class, attendance means active participation; students are expected to spend at least 2 hours/week on the discussion threads and at

least 10 hours/week is required to complete all the assignments, including reading. If you are unable to log on for an extended period of time (greater than a week) then contact me *in advance* to discuss how to proceed. We recognize that many of you already have a busy work schedule, and that occasionally you might get behind in a unit. Spending even 15-30 minutes a day on class material and the discussion threads will help greatly, ***and if you find yourself struggling at any time, please do not hesitate emailing me; I can be flexible to accommodate your busy schedule.***

Assignment policy

Students will be responsible for knowing when due dates for assignments are by reading the syllabus, looking at the schedules under "Course Home" and in this syllabus, and reading the relevant sections when posted on MyleoOnline.

Netiquette: Communication Courtesy Code

Students are expected to follow rules of common courtesy in all email messages, threaded discussions and chats. The same rules apply online as they do in person. Be respectful of other students. Foul discourse will not be tolerated. Please take a moment and read the following links concerning "netiquette". http://www.albion.com/netiquette/
http://www2.nau.edu/d-elearn/support/tutorials/discrubrics/netiquette.php

UNIVERSITY SPECIFIC PROCEDURES

University Specific Procedures

Student Conduct

All students enrolled at the University shall follow the tenets of common decency and acceptable behavior conducive to a positive learning environment. The Code of Student Conduct is described in detail in the Student Guidebook.
http://www.tamuc.edu/Admissions/oneStopShop/undergraduateAdmissions/studentGuidebook.aspx

Students should also consult the Rules of Netiquette for more information regarding how to interact with students in an online forum: Netiquette
http://www.albion.com/netiquette/corerules.html

TAMUC Attendance

For more information about the attendance policy please visit the Attendance webpage and Procedure 13.99.99.R0.01.
http://www.tamuc.edu/admissions/registrar/generalInformation/attendance.aspx

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/academic/13.99.99.R0.01.pdf

Academic Integrity

Students at Texas A&M University-Commerce are expected to maintain high standards of integrity and honesty in all of their scholastic work. For more details and the definition of academic dishonesty see the following procedures:

Undergraduate Academic Dishonesty 13.99.99.R0.03

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/undergraduates/13.99.99.R0.03UndergraduateAcademicDishonesty.pdf

Graduate Student Academic Dishonesty 13.99.99.R0.10

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/graduate/13.99.99.R0.10GraduateStudentAcademicDishonesty.pdf

ADA Statement

Students with Disabilities

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you have a disability requiring an accommodation, please contact:

Office of Student Disability Resources and Services
Texas A&M University-Commerce
Gee Library- Room 162
Phone (903) 886-5150 or (903) 886-5835
Fax (903) 468-8148
Email: studentdisabilityservices@tamuc.edu
Website: Office of Student Disability Resources and Services
http://www.tamuc.edu/campusLife/campusServices/studentDisabilityResourcesAndServices/

Nondiscrimination Notice

Texas A&M University-Commerce will comply in the classroom, and in online courses, with all federal and state laws prohibiting discrimination and related retaliation on the basis of race, color, religion, sex, national origin, disability, age, genetic information or veteran status. Further, an environment free from discrimination on the basis of sexual orientation, gender identity, or gender expression will be maintained.

Campus Concealed Carry Statement

Texas Senate Bill - 11 (Government Code 411.2031, et al.) authorizes the carrying of a concealed handgun in Texas A&M University-Commerce buildings only by persons who have been issued and are in possession of a Texas License to Carry a Handgun. Qualified law enforcement officers or those who are otherwise authorized to carry a concealed handgun in the State of Texas are also permitted to do so. Pursuant to Penal Code (PC) 46.035 and A&M-Commerce Rule 34.06.02.R1, license holders may not carry a concealed handgun in restricted locations.

For a list of locations, please refer to the Carrying Concealed Handguns On Campus
document and/or consult your event organizer.

Web url:
http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/34SafetyOfEmployeesAndStudents/34.06.02.R1.pdf

Pursuant to PC 46.035, the open carrying of handguns is prohibited on all A&M-Commerce campuses. Report violations to the University Police Department at 903-886-5868 or 9-1-1.

COURSE OUTLINE / CALENDAR

This schedule is tentative.

The dates given in the first column are what I'm defining to be the begin and end dates of each week, from when the week's material becomes available to when the quiz and discussion posts are due.

During weeks 1-6 we will also practice some necessary background math and introduce Dirac notation. We will mostly be reading journal articles for weeks 1-6, including some primary sources.

Week	**Topic**
1	19th C physics, black body radiation/Max Planck/the quantum
2	Einstein/Photoelectric effect
3	The Bohr-Sommerfeld atom
4	Heisenberg/Matrix mechanics, uncertainty principle
5	Schrödinger/Wave mechanics/wavefunctions
6	The Copenhagen Interpretation/Intro to quantum states
7	Quantum States/Stern-Gerlach Experiment
8	Quantum States/Stern-Gerlach Experiment II/
9	Operators/Quantum Zeno
10	Quantum tunneling/commutation
11	Time Dependence
12	Entanglement, EPR and Bell's Theorem

SCHEDULE OF SPECIFIC ASSIGNMENTS

	READING	TUTORIAL	HOMEWORK	ASSESSMENTS
WEEK 1	Planck 1900,1901	Dirac 1	Complex numbers	
WEEK 2	Einstein 1905	Dirac 2	Eigenvalues,eigenvectors	
WEEK 3	Bohr 1913	Dirac 3	Correspondance Principle*	
			HW TURN-IN 1	
WEEK 4	Heisenberg 1925, Born 1925 Fedak 2009	Dirac 4		Assessment: Dirac Notation Tutorial
WEEK 5	Schrodinger 1926 McKagan 2008			
WEEK 6	Heisenberg 1926 Born 1926 Pais 1982 Johansson 2008			
			HW TURN-IN 2	ASSESSMENT TURN IN
WEEK 7		Stern-Gerlach	Spins 1	Assessment: Quantum Key
WEEK 8		Spins Lab part 1		
WEEK 9	Zhu 2011	Spins Lab part 2		
			HW TURN-IN 3	ASSESSMENT TURN IN
WEEK 10		Quantum Mouse	Operators*	Assessment: Lamor Precession
WEEK 11		2-state Time Dependence		
WEEK 12	Einstein 1935 Mermin 1985			
			HW TURN-IN 4	ASSESSMENT TURN IN

+ WEEKLY QUIZZES AND DISCUSSION POSTS

COURSE DUE DATES: DISCUSSION POSTS

Each week you must post at least **one** post in each of **two different** discussion threads, giving your initial thoughts on the subject of the thread or any conceptual or mathematical difficulties you are having with the thread subject. You must also post at least **one** follow up posts in your choice of the **previous week's** threads, responding to another person's comments, or one of my comments. That makes a total of **three** posts per week that will be graded.

Discussion threads for a particular week open at **12.01 a.m.** each **Friday** with the rest of the week's material. To receive credit for your posts, they must be made within the time-frame outlined below. The threads remain open until the end of the semester.

WEEK	DISCUSSION THREADS OPEN	2 POSTS IN DIFFERENT THREADS DUE	1 FOLLOW-UP POST DUE
Introductions	Jan 17		
1	Jan 20	Jan 29	Feb 5
2	Jan 27	Feb 5	Feb 12
3	Feb 3	Feb 12	Feb 19
4	Feb 17	Feb 26	Mar 5
5	Feb 24	Mar 5	Mar 12
6	Mar 3	Mar 12	Mar 19
	Sprint Break March 13-17		
7	Mar 17	Mar 26	Apr 2
8	Mar 24	Apr 2	Apr 9
9	Mar 31	Apr 9	Apr 16
10	Apr 14	Apr 23	Apr 30
11	Apr 21	Apr 30	May 7
12	Apr 28	May 7	

COURSE DUE DATES: QUIZZES AND PERUSALL ASSIGNMENTS

The introductory week's **syllabus quiz** becomes available on **Wednesday Jan 12th** at **12.01 a.m.** *For the syllabus quiz only, you may take the quiz as many times as you like. You will only gain access to the first week of material once you have made 100% on the syllabus quiz and have completed.* Quizzes on each week's reading material become available at **12.01 a.m.** each **Friday** along with the rest of the week's material, and close at **11.59 p.m. (midnight)** the following **Sunday, 9 days later**.

NOTE: *Apart from the syllabus quiz, quizzes can only be attempted once. Once you begin taking the quiz, you will have a time limit of one hour to complete it. Once completed, you cannot return to it and revise your answers.*

Perusall assignments – tutorials and reading – are available the same day as the quiz, but are due one week after the quiz (so you have just over 2 weeks to complete the perusal assignments, except for the first ones for which you have just over 3 weeks). NOTE: Not all weeks have Reading or Tutorial Perusall assignments – see assignment schedule for specifics.

WEEK	QUIZ AVAILABLE/READING AND TUTORIAL ANNOTATION ON PERUSALL STARTS	QUIZ DUE	READING AND TUTORIAL ANNOTATION ON PERUSALL ENDS
	Jan 17 (Syllabus Quiz)	Access to course requires completion	
1	Jan 20	Jan 29	Feb 05
2	Jan 27	Feb 5	Feb 12
3	Feb 3	Feb 12	Feb 19
4	Feb 17	Feb 27	Mar 5
5	Feb 24	Mar 6	Mar 12
6	Mar 3	Mar 13	Mar 19
	Spring Break March 13-17		
7	Mar 17	Mar 26	Apr 2
8	Mar 24	Apr 2	Apr 9
9	Mar 31	Apr 9	Apr 16
10	Apr 14	Apr 23	Apr 30
11	Apr 21	Apr 30	May 7
12	Apr 28	May 7	

COURSE DUE DATES:
HOMEWORKS/ASSESSMENTS

When a new week has associated homework, it becomes available at the start of that week, on **Friday** at **12.01 a.m.** They are due at **11:59pm** on the due dates shown in the calendar below. I do make all the homeworks/assessments available in a separate module so you have the option of working ahead if time permits.

WEEK	HW AVAILABLE	HW DUE
1	Jan 20	Feb 19
2	Jan 27	
3	Feb 3	
4	Feb 17	Mar 19
5	Feb 24	
6	Mar 3	
	Spring Break March 13-17	
7	Mar 17	Apr 16
8	Mar 24	
9	Mar 31	
10	Apr 14	May 10
11	Apr 21	
12	Apr 28	