COURSE AND INSTRUCTOR INFORMATION

Course: PHY 420 (Atomic Physics & Quantum Mechanics)
Lecture Location: Anderson 222
Lecture Time: Tuesday, Thursday: 2:00 pm – 3:15 pm

Instructor: Anil K. Kandalam (Dr. Kandalam or Dr. K)
Office Location: Schmucker Science South, SS 403A
Email: akandalam@wcupa.edu
Office Hours: Monday, Wednesday: 9:00 am – 11:00 am
Thursday: 9:00 am – 10:00 am or by appointment

COURSE OBJECTIVE

This course is an introductory quantum mechanics course. The goal is for you to acquire a firm grasp of the following fundamental topics: the Schrodinger equation, Solutions to systems with stationary states (potential step, potential well, potential barrier, and harmonic oscillator), an abstract view of quantum mechanics (Dirac notation, Operator methods), the hydrogen atom, Angular momentum, Spin, and if time permits, perturbation theory.

REQUIRED COURSE MATERIALS

Textbook: *Introduction to Quantum Mechanics*, David J. Griffiths, 2nd Edition (Pearson)

Reference books for additional reading:
Introductory Quantum Mechanics, Richard Liboff (Addison-Wesley)
Quantum Mechanics: An Accessible Introduction, Robert Scherrer (Addison-Wesley)
Quantum Mechanics, Bruce Cameron Reed (Jones and Bartlett)
Quantum Mechanics, Eugen Merzbacher (Wiley)
Quantum Mechanics for Scientists and Engineers, David A. Miller (Cambridge)

Note: In some lectures, I will cover certain topics in class that are not discussed in Griffiths. They will be taken from the "Reference books" listed above.

EXPECTATIONS

This is a challenging course. Not only are the concepts challenging, but there is a lot of math. You will be using topics from calculus, linear algebra, differential equations, and concepts from mathematical physics. Given the complexity of this course as well as the required mathematical background, you will have to put in a substantial amount of effort. You cannot rely on your time in class and the associated lectures alone to master the topics presented. You will have to spend a great deal of time outside class reading the material covered in the text, studying the examples provided, and working on the problem sets. If you have not done this up to now in your other classes please be forewarned. Don't hesitate to ask me or other professors for help in the material that you have trouble understanding. **DO NOT fall behind in this class!**
Prerequisites: PHY 240, PHY 300, and MAT 343 (or PHY 370). Linear Algebra, although is not technically a prerequisite, might as well be one. If you have not taken all of these courses, it is not a disaster, but you should be ready to learn new math concepts along with new concepts in physics.

LEARNING OUTCOMES

Program (B. S. Physics) student learning outcomes:
Physics 420 fulfills the goal of students' knowledge and understanding of the concepts and principles of physics as outlined in the departments program assessment.

Course-specific learning outcomes:
Outcome 1: Students will demonstrate the ability to explain the Schrodinger Equation and its Statistical Interpretation.
Outcome 2: Students will demonstrate an ability to solve the one-dimension, time-independent Schrodinger equation for various situations, such as an infinite potential well, the harmonic oscillator, finite potential well, and potential barrier.
Outcome 3: Students will demonstrate an ability to interpret and explain the formalism wave functions in Hilbert space, identify and use the Hermitian Operators, and use the Dirac notation.
Outcome 4: Students will be able to apply the Schrodinger equation in three dimensions (in spherical coordinates) and solve it for central potentials, such as hydrogen atom.
Outcome 5: Students will demonstrate an understanding of the angular momentum and electron spin from quantum mechanical view point.

ASSESSMENT OF LEARNING OUTCOMES

Learning goals and outcomes will be assessed will be assessed via weekly homework problem sets, in-class and take-home exams and the final exam.

COURSE COMPONENTS

Pre-class Reading: You must read before coming to the class. Since, we have limited lecture time, we must focus on the more challenging concepts in the course. Thus, it is critical that you come to lecture knowing the basic elements which we will build on in lecture that day. You need to think deeply about the content and might need to read certain section multiple times.

Lecture: I attempt to make the lecture as informal as possible. I encourage questions during the class.

Problem Sets: Problems will be assigned almost every class period and they are due as a **packet** on Tuesday during the first five minutes of class**. No late problem sets will be accepted.** Working the problem sets is very important for mastering this subject. All problem sets will be graded (***to varying degrees***) and returned the following week (typically during Tuesday class time). If you fail to turn in a problem set because of absences (excused or unexcused) then you will receive a zero for the problem set grade. **The problem sets will be graded only roughly.** It is your responsibility to check your work with the solution set.

EVALUATION

The final grade for this course will be based on the following:

- Problem Sets ……20%
- Exams (2 @ 25% each) ……50%
- Final exam…….....30%

I will be using the official WCU scale of grades, see p.92 in the undergraduate catalog (2015-2016).

However, I reserve the right to adjust the weights of individual components, or the scale to account for unforeseen circumstances.

GRADING COMPONENTS AND POLICIES

Problem Sets: You are encouraged to work together/collaborate on problem sets, but the work that you hand in must be your own and must reflect your own understanding of the material. The best balance between working alone and working with other people is to (i) first work on the problem sets alone. If you are stuck on a problem, then (ii) work with other students and then (iii) complete the problem alone where you can collect your thoughts in peace. Make sure that you understand the solution to each problem that you turn in. If step (ii) does not help, you can always get hints from me during my office hours. Please do not ask from help/hints via. e-mail.

Please indicate the names of people you have collaborated with for a problem set. It is likely that your work will look similar to that of classmates with whom you worked/collaborated, but if you prepare your own answers for submission there will be differences in how you express your results. **If you just copy someone else's homework answers and/or copy from instructors solutions manual (available to you in hard copy or you/someone else found it online), it amounts to violation of academic integrity.**

Finally, please staple your homework before you submit it, and cut off any "scruff" from spiral notebooks.

Regular Exams: There are no-make up exams. The exceptions, however, are limited to the absences related to University Sanctioned Events (see below). If you miss an exam for a University Sanctioned Event, you must notify me in advance so that we can arrange for you to take the exam in a manner consistent with its integrity. You must also provide some form of documentation (performing arts program, competition schedule etc.

Final Exam: The final exam is a cumulative exam and is MANDATORY. The date and time of the final exam for this course (as set by the registrar, as of 01/18/2017) is:

Thursday, May 11, 2017 from 1:00 pm – 3:00 pm

You should plan to be available for the entire finals week. We have in past semesters had to reschedule finals due to weather related events.

ATTENDANCE POLICY

A regular attendance to the lectures is an important part of this course and I highly recommend it. This is your chance to ask questions, see examples and get help in solving problems. I am here to guide you through the material. Attendance will benefit your understanding and therefore grade. However, I do not give an attendance grade. Students must understand that they are responsible for all material covered and assigned during their absences (excused and unexcused) and that they are responsible for the academic consequences of their absences.

CONTACT POLICY

Please include ***PHY420*** in the subject line of any e-mail. I try to respond to e-mail within 24hrs. Although I will try to answer all questions directed to me by e-mail, most problems related to course content are best discussed during office hours.

DISABILITY STATEMENT

If you have a disability that requires special accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodation and meet with me as soon as possible so that I can support your success in an informed manner. Also, contact the Office of Services for Students with Disabilities (OSSD) at (610) 436-2564, their email address is ossd@wcupa.edu, and their website is www.wcupa.edu/ussss/ossd. Sufficient notice is needed to make the accommodations possible. Both the WCU and I desire to comply with the ADA of 1990.

ACADEMIC INTEGRITY & CONDUCT

I have a zero-tolerance policy for breaches of academic integrity. It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Undergraduate Handbook, the Undergraduate Catalog, the *Ram's Eye View*, and the University website at www.wcupa.edu.

UNIVERSITY SANCTIONED EVENTS

If you are participating in a University sanctioned event during one of our scheduled exams you must notify me in advance. You must provide some form of documentation. We can then arrange for you to take the exam in a manner consistent with exam integrity. Students are advised to carefully read and comply with the excused absences policy for university-sanctioned events contained in the WCU Undergraduate Catalog. Please note that the "responsibility for meeting academic requirements rests with the student," that this policy does not excuse students from completing required academic work, and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

E-MAIL POLICY STATEMENT

It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.

ALL OTHER ACADEMIC POLICIES

For any university-wide academic policy not explicitly covered in this document, such NO Grade policies, please consult your major advising handbook, the Undergraduate Catalog, the Ram's Eye View, or University Website.

TITLE IX STATEMENT

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator, Ms. Lynn Klingensmith. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University protection of minors policy. Information regarding the reporting of sexual violence and the resources that

are available to victims of sexual violence is set forth at the webpage for the Office of Social Equity at http://www.wcupa.edu/_admin/social.equity/.

EMERGENCY PREPAREDNESS

All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

TENTATIVE SCHEDULE (This schedule is subject to revision.)

	Date		Topic
1	T	Jan. 24	Constructing the Schrodinger's Equation (*not from Griffiths*), SE in one-dimension
2	R	Jan. 26	Ch. 1: The meaning of the Wave function, Normalization and Expectation Values
3	T	Jan. 31	Ch. 2: Stationary States, Infinite Square Well (*re-visit*)
4	R	Feb. 2	Ch. 2: Infinite Square Well & Symmetric Potential Well
5	T	Feb. 7	Bound States and Unbound States, Free Particle (*not from Griffiths*)
6	R	Feb. 9	Ch. 2: Step Potential
7	T	Feb. 14	Ch. 2: Step Potential, Square Potential Barrier (*in lieu of Delta-function Potential*)
8	R	Feb. 16	Potential Barrier & Tunneling (*not from Griffiths*)
9	T	Feb. 21	Potential Barrier & Tunneling
10	R	Feb. 23	Ch. 2: Finite Potential Well
11	T	Feb. 28	Ch. 2: Finite Potential Well
12	R	Mar. 2	Ch. 2: Harmonic Oscillator (*Analytic Method*)
13	T	Mar. 7	Ch. 2: Harmonic Oscillator (*Analytic Method*)
14	R	Mar. 9	**TEST 1**
	T R	Mar. 14 Mar. 16	**SPRING BREAK**
15	T	Mar. 21	Ch. 3: Linear Operators, Hilbert Space
16	R	Mar. 23	Ch. 3: Adjoint and Hermitian Operators
17	T	Mar. 28	Ch. 3: Eigen functions and Eigen values, Dirac Notation
18	R	Mar. 30	Ch. 4: Schrodinger Equation in Spherical Coordinates
19	T	Apr. 4	Ch. 4: Angular Momentum
20	R	Apr. 6	Ch. 4: Angular Momentum, Hydrogen Atom
21	T	Apr. 11	Ch. 4: Hydrogen Atom
22	R	Apr. 13	Ch. 4: Hydrogen Atom, Matrix Formulation of Linear Operators
23	T	Apr. 18	Ch. 4: Matrix Formulation of Linear Operators, Spin
24	R	Apr. 20	Ch. 4: Matrix representation of Spin, Pauli Spin matrices
25	T	Apr. 25	Ch. 4: Electron in a Magnetic Field
26	R	Apr. 27	**TEST 2**
27	T	May 2	Ch. 4: Stern Gerlach/Larmour Precession
28	R	May 4	Ch. 4: Addition of Angular Momenta