Physics 421 - Quantum mechanics - Fall 2020

Instructor	Renate Wackerbauer, Office Location: REIC 106 phone: 474-6108 e-mail: rawackerbauer@alaska.edu
Open Office hours	Due to Covid19 there are no walk-in office hours unless the situation improves; meeting via zoom works; email is effective for straight-forward questions. additional recitation classes can be scheduled on request.
Course Info	Phys421, 4 credits
Prerequisites	Phys213, 220, 301, 341; or permission of instructor.
Lectures	MWF 10:30 to 11:30 am, M 3:30-4:30, REIC 207. Lectures will be/start f2f; they will be recorded, uploaded to "google classroom", and shared with all students in class. Due to the fluid situation with covid, the course modality can change throughout the semester. In the case of online course delivery, lectures would be offered synchronously (tablet with whiteboard), recorded, and uploaded into google classroom.
Noyes Lab	Access to the Noyes Computer Lab (REIC 101) is provided to all students enrolled in a Physics course. Your polar express card lets you in.
Text	Required text: *Introduction to Quantum Mechanics*, by D.J. Griffiths and D. F. Schroeter, Cambridge University Press (3rd edition, 2018) Supplementary readings: *Quantum Physics*, by R. Eisberg and R. Resnick, Wiley (1985) --This book represents a detailed introduction into modern quantum physics, tells also about the history and experiments in QM. *Lectures on Quantum mechanics*, by G. Baym, Benjamin/Cumings (1973) --for further reading, usually at graduate level *Quantum Mechanics*, by F. Schwabl, Springer (2001) --clearly written introduction; good basis for the author's book on advanced quantum mechanics. *The infinite well and Dirac delta function potentials as pedagogical, mathematical and physical models in QM*, M. Belloni and RW. Robinett, Physics Reports, 2014 -- for further reading with interesting applications *There are many books on introductory quantum mechanics in the library that almost all cover the material presented in the lectures. Please explore them to see different approaches to our topics.*
Course Content Tentative course	Schroedinger's equation, Born interpretation, operator formalism, measurement and projection, stationary states, one-dimensional systems, hydrogen atom, states of definite angular momentum, perturbation theory

calendar	
Course Goals	This course provides an introduction into quantum mechanics, the physics of the microscopic particles like electrons, protons, atoms, etc. The Schroedinger equation - the quantum mechanical equation of motion is studied in very detail for different physical systems. Where does Heisenberg's uncertainty relation really come from, is there just one or are there many?
Student Learning Outcomes	Students learn, --how particle behavior in the microscopic world differs from the macroscopic world --how to describe and solve problems in theoretical quantum mechanics --some limitations of classical analogons in quantum mechanics --how measurement processes are different in quantum mechanics and classical physics
Homework **homework**	Homework (10 assignments, each counting 100pts) will be assigned weekly via "google classroom" and will be due by **2:00 pm** on the following Friday, unless explicitely altered at the time of assignment. Late homework will not be accepted. Finished homework should be uploaded to "google classroom". You can earn 100 bonus points in the homework by giving a 10min presentation to class on a topic related to class, for example the life of a quantum physicist, an application of quantum mechanics, experiments on quantum mechanics, etc. in case of issues with the homework link use: ffden-2.phys.uaf.edu/wacker/CLASS/421.html
Examinations	Two one-hour in-term examinations and a two hour final examination will be held during the semester. In-term exams will be held in the classroom. Upon request, an additional review class may be scheduled before each exam. The exams will be closed books and closed notes. No calculators, computers, or communication devices are allowed. Exam 1 (in class) — Fri, Oct 9 — Griffiths: approx. chapt. 1-3 Exam 2 (in class) — Fri, Nov 13 — Griffiths: approx. chapt. 4-6 Final Exam — Wednesday, Dec 9, 10:15-12:15am — Griffiths: approx. chapt. 1-9
Grading	The maximum score for each homework will be 100 points. *Illegible work will not be graded*. To pass the course with a grade higher than "F", you need 40% of the total credits. Grades A to D are assigned equal weight for total credits between 40% and 100%. So, A+ (>97.5), A(>87.5), A-(>85), B+(>82.5), B(>72.5), B-(>70), C+(>67.5), C(>57.5), C-(>55), D+(>52.5), D(>42.5), D-(>40). If this class is in your major you need at least a grade C- for passing the course and fulfilling prerequisites. For the final grade, homework, exams, etc. will be weighted as follows: Homework — 20% Exam 1 — 25% Exam 2 — 25% Final Exam — 30%

Course policies	Attendance at lectures is expected. Active class participation, questions are extremely welcome in the lectures. A missed exam will receive 0 credit unless the instructor is notified by email, phone, etc before the exam starts. Make-up exams will be individually scheduled with the student.
Student Obligations	As students of UAF, you are bound by the policies and regulations of the University of Alaska, UAF rules and procedures, and the Student Honor Code. You are obligated to make yourselves familiar with all conditions presented in the UAF Catalog. *Plagiarism on homework or on an exam will result in a failing grade.* *Students should keep up-to-date on the university's policies, practices, and mandates related to COVID-19 by regularly checking this website:* *Further, students are expected to adhere to the university's policies, practices, and mandates and are subject to disciplinary actions if they do not comply.*
Student protection and services statement	Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc. to find reasonable accommodations. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. As required, if I notice or am informed of certain types of misconduct, then I am required to report it to the appropriate authorities. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handbook/. UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: https://alaska.edu/nondiscrimination/. Your instructor follows the University of Alaska Fairbanks Incomplete Grade Policy: "The letter "I" (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C or better) the majority of work in a course but for personal reasons beyond the student's control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an "I" grade." Effective communication: Students who have difficulties with oral presentations and/or writing are strongly encouraged to get help from the UAF Department of Communication's Speaking Center (907-474-5470, speak@uaf.edu) and the UAF English Department's Writing Center (907-474-5314, Gruening 8th floor), and/or CTC's Learning Center (604 Barnette Street, 907-455- 2860).

Tentative weekly course calendar for Phys421 (4 lectures per week)

Week	Date	Topics covered
1	aug 24-28	Introduction, "old" quantum mechanics, Schroedinger's equation
2	aug 31-4	Schroedinger's equation, Born's interpretation No HW due this week! Sept 4: Last day to drop
3	sept 7-11	time-independent Schroedinger equation, particle in box HW#1 due friday
4	sept 14-18	QM potential: harmonic osciillator, free particle, delta potential: binding and scattering, square-well potential HW#2 due friday
5	sept 21-25	QM potential: delta potential, square well potential, tunneling, resonances HW#3 due friday
6	sept 28-2	Axoms of QM: Hermitian operator, Hilbert space, discrete and continuous eigen spectrum, measurement process HW#4 due friday
7	oct 5-9	uncertainty principle, Ehrenfest theorem, symmetries and conservation laws no HW due this week EXAM1: Friday, Oct 9
8	oct 12-16	QM in 3 dimensions: angular and radial wave equation, infinite well problem, H-atom HW#5 due friday
9	oct 19-23	degeneracy, angular momentum, commutators, HW#6 due friday
10	oct 26-30	spin, spin measurement, electron in magnetic field HW#7 due friday Oct 30: Last day to withdraw
11	nov 2-6	addition of angular momentum, time-independent perturbation theory (TIP) HW#8 due friday
12	nov 9-13	TIP (degenerate case) + examples H-atom: relativistic corrections (T, SO), presence of magnetic field No HW due this week EXAM2: Friday, Nov 13
13	nov 16-20	identical particles: bosons, fermions, Pauli principle, atoms + periodic table HW#9 due friday
14	nov 23-27	time-dependent perturbation theory and examples No HW due this week Finally!!!!!!! Thanksgiving break: Nov 25-27
15	nov 30-4	Einstein's equations, Laser, transition rules, Planck's BB radiation HW#10 due WEDNESday Last day of instruction: Dec 4

16	dec 7-11	FINAL: Wednesday Dec 9, 10:15-12:15 am ..... GOOD SUCCESS .....