

SYLLABUS (Subject to Modification)

PHYS. 5510.001

Quantum Mechanics II

Dr. Sandra Quintanilla

Spring 2022

Lecture: MWF 9:00 – 9:50 a.m.

Physics 116

Office: Physics 309

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Phone: 565-4739 (Microsoft teams)

Office hours: MW 10:00 a.m. – 10:30 a.m.

F 10:00 a.m. – 11:00 a.m.

or by appointment.

Prerequisite(s): PHYS. 5500 Quantum Mechanics I

Recommended Prerequisites:

PHYS. 5500 Quantum Mechanics I

MATH. 2700: Linear Algebra and Vector Geometry

MATH. 3410: Differential Equations I

MATH. 3420: Differential Equations II

PHYS. 3310: Mathematical Methods in the Physical Sciences

PHYS. 4310: Quantum Mechanics

Required Text:

- *Principles of Quantum Mechanics*, R. Shankar, 2nd Edition, (Springer Science+Business Media, Inc. 1994) ISBN; 0-306-44790-8.

Useful Resources:

- *Introduction to Quantum Mechanics*, David J. Griffiths and Darrell F. Schroeter, 3rd Edition.
- *Basic Quantum Mechanics*, J. M. Cassels, 2nd Edition, (McGraw-Hill Ltd, 1982) ISBN: 0 333 18599.
- *Quantum Mechanics*, Eugen Merzbacher, 3rd Edition, (John Wiley & Sons, Inc. 1961, 1970, 1988, 1998) ISBN: 0-471-88702-1.
- *Quantum Mechanics*, Leonard I. Schiff, (International Student Edition, McGraw-Hill International Book Company, 1968) ISBN 9-07-085643-5.
- *Introductory Quantum Mechanics*, R. L. Liboff, 2nd Edition, (Addison-Wesley Publishing Company, Inc., 1992) ISBN 0-201-54715-5.
- *Quantum Physics*, Stephen Gasiorowicz, (John Wiley, 1974).
- *Quantum Mechanics*, Albert Messiah, Two volumes bound as one, Dover Publications, Inc., ISBN-13: 978-0-486-78455-7; ISBN-10: 0-486-78455-X
- *Physics of Atoms and Molecules*, B. H. Bransden and C. J. Joachain, 2nd Edition, 2003 Prentice Hall, An imprint of Pearson Education, Harlow, England, London, New York, ISBN 0582 35692 X.
- *Mathematical Methods for Science Students*, G. Stephenson.
- *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*, R. Eisberg and R. Resnick, (John Wiley & Sons 1974, 1985), ISBN: 0-471.12.E34.
- *Mathematical Methods for Physicists, A Comprehensive Guide*, 7th Edition, George B. Arfken, Hans J. Weber, and Frank E. Harris, Academic Press, An imprint of Elsevier elsevierdirect.com, ISBN-13: 978-0123846549, ISBN-10: 0123846544.

- *NIST Digital Library of Mathematical Functions*, <http://dlmf.nist.gov/>
- [http://www.demonstrations.wolfram.com/search.html?query=Quantum Mechanics](http://www.demonstrations.wolfram.com/search.html?query=Quantum+Mechanics)

Technology:

From the `unt_syllabus_template`, <https://clear.unt.edu/teaching-resources/unt-syllabus-template>: “To fully participate in this class, students will need internet access to reference content on the Canvas Learning Management System.” Please have access to Mathematica. The University has a site license for Mathematica. If you can not come to class and have a legitimate reason for not coming to class, for example, Covid-19, Covid-19 symptoms, please email me at least 15 minutes before class, and then please attend class via Zoom if you can. The Zoom link for class is on *Canvas*. Currently, class and exams are scheduled to be in classroom Phys. 116. If the plan changes, I plan to try to notify you by email and sending a message on Canvas. If the exams are changed to be in virtual, Zoom and a webcam are required. “Information on how to be successful in a digital learning environment can be found at Learn Anywhere (<https://online.unt.edu/learn>). ”

Course Content: 3 hours. Scattering theory; spin, angular momentum; WKB and variation method; time-independent and time-dependent perturbation theory; identical particles; applications; relativistic waves equations.

Course Content for Phys. 5500: Fundamentals of quantum theory. Foundations of wave mechanics, wavepackets and the uncertainty principles. Schrödinger equation, one-dimensional problems, operators and eigenfunctions, three-dimensional problems, angular momentum and spin.

Course Objectives for both Phys. 5500 and Phys. 5510:

- To have a solid foundation in Quantum Mechanics.

Exams: There are three term exams and one final exam. Exams can be based on the text reading, any other assigned readings, class lectures, homework, *Canvas* postings, and any additional material given. The exams are closed book exams and calculators may not be used. They are currently to take place in-person on campus (Phys. 116). However, if the situation changes, I plan to notify you via *Canvas*. If the exams are required to be done virtually, then I require that you use Zoom and a webcam. In general, I do not give make-up exams. If you are sick, please provide me with an official medical note. If you have COVID-19, COVID-19 symptoms and/or in quarantine, please email COVID@UNT.edu and email myself. <https://healthalerts.unt.edu/>

Homework: In general weekly homework to submitted on *Canvas* by the deadline. For homework assignments, please see *Canvas*. I plan to drop the lowest homework score. No-late homework is accepted unless permission granted by myself. If you are sick, please email me an official medical note.

Reading and Preparation:

- Read appropriate sections of the book before class.
- Read from additional material if suggested.
- Please look at Mathematica files and/or pdf files that are referenced or given on *Canvas*.
- Read class notes and book after class.

Quizzes: The plan is to pass out quizzes in class or to post them on *Canvas* to do either during class or outside class. The quizzes do not help directly towards your grade, but should be taken seriously.

Grading:

Three unit exam average	60%	A: 90-100
Homework	15%	B: 80-89
Comprehensive final	25%	C: 70-79
	100%	D 60 -69
		F: < 60

Canvas: Please check *Canvas* daily Monday-Saturday for possible announcements, Mathematica files, references, quizzes, homework assignments, etc.

A class or classes may be recorded using Zoom. If so, class recordings may be posted on *Canvas*. Any Class Recordings posted on *Canvas* are specifically for this course and must not be used elsewhere.

“Class recordings are the intellectual property of the university or instructor and are reserved for use only by students in this class and only for educational purposes. Students may not post or otherwise share the recordings outside the class, or outside the Canvas Learning Management System, in any form. Failing to follow this restriction is a violation of the UNT Code of Student Conduct and could lead to disciplinary action.”

<https://vpaa.unt.edu/office-provost/covid-19-update-32720>

<https://vpaa.unt.edu/return>

Attendance: Required attendance for class unless a student has a legitimate reason not to attend a particular class or classes. Participation in class is important. Attending class should be helpful with your learning and with your motivation. If you plan to miss a class or if you miss a class, please email me. If you do not attend class for the first 12 day period I think you will receive a message from the Register’s Office.

From the `unt_syllabus_template`, <https://clear.unt.edu/teaching-resources/unt-syllabus-template>: “Attendance language for students during COVID: Students are expected to attend class meetings regularly and to abide by the attendance policy established for the course. It is important that you communicate with the professor and the instructional team prior to being absent, so you, the professor, and the instructional team can discuss and mitigate the impact of the absence on your attainment of course learning goals. Please inform the professor and instructional team if you are unable to attend class meetings because you are ill, in mindfulness of the health and safety of everyone in our community. If you are experiencing any symptoms of COVID (<https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>) please seek medical attention from the Student Health and Wellness Center (940-565-2333 or askSHWC@unt.edu) or your health care provider PRIOR to coming to campus. UNT also requires you to contact the UNT COVID Team at COVID@unt.edu for guidance on actions to take due to symptoms, pending or positive test results, or potential exposure.”

<https://vpaa.unt.edu/return>

“Remote instruction may be necessary if community health conditions change or you need to self-isolate or quarantine due to COVID-19. Students will need access to a webcam to participate in fully remote portions of the class. Additional required classroom materials

for remote learning may include a LockDown Browser. Information on how to be successful in a remote learning environment can be found at <https://online.unt.edu/learn>.”
<https://vpaa.unt.edu/return>

COVID-19: *Please be considerate of each other and treat each other like you would like to be treated.*

CDC guidelines: <https://healthalerts.unt.edu/covid-guidelines>

<https://vpaa.unt.edu/return>

<https://www.untsystem.edu/unt-system-covid-19-information>

<https://www.untsystem.edu/unt-system-covid-19-information#toc-3>

<https://healthalerts.unt.edu/>

From the website <https://www.untsystem.edu/unt-system-covid-19-information#toc-3>:

“CDC continues to recommend wearing a mask in public indoor settings in areas of substantial or high community transmission, regardless of vaccination status.”

From the website <https://vpaa.unt.edu/return>: “UNT encourages everyone to wear a face covering when indoors, regardless of vaccination status, to protect yourself and others from COVID infection, as recommended by current CDC guidelines. Face covering guidelines could change based on community health conditions.” .. “Under the Governors executive order, UNT cannot require students, staff or faculty to wear a face covering.”

If you have COVID-19, COVID-19 symptoms or are in quarantine, please send an email to COVID@unt.edu and myself. (<https://healthalerts.unt.edu>)

Registration: Office of the Registrar: <https://registrar.unt.edu/>

<https://registrar.unt.edu/registration/spring-registration-guide>

Student Evaluation System: “Student feedback is important part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT.” The plan is for the SPOT survey to be available to you end of the semester. It gives “you with an opportunity to evaluate how this course is taught.”

<https://vpaa.unt.edu/file/33330>

<http://vpaa.unt.edu/spot>

<https://vpaa.unt.edu/spot/calendars/spring22calendars>

Policies, Procedures and Resources:

<https://teachingcommons.unt.edu/teaching-handbook/definitions-and-policies/>

<https://teachingcommons.unt.edu/teaching-handbook/definitions-and-policies/unt-teaching-policies>

Emergency Notifications & Procedures:

<https://teachingcommons.unt.edu/teaching-handbook/definitions-and-policies/unt-teaching-policies/emergency-notifications-procedures>

“Emergency Notification & Procedures. UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Blackboard for contingency plans for covering course materials.” [Blackboard → Canvas ?]

<https://emergency.unt.edu/>

<https://emergency.unt.edu/emergency-guidelines-0>

https://emergency.unt.edu/sites/default/files/my_unt_emergency_plan-filesizedreduced.pdf

<https://emergency.unt.edu/emergency-floor-plans>

https://emergency.unt.edu/sites/default/files/physics_building.pdf

If there is a tornado or hurricane, please proceed to the physics basement.

Electronics: Cell phones, iPads, tablets, etc, are to be turned off during class other than for a class related activity.

Office Hours: Please come to my office Phys. 309 during office hours, or by appointment, during the first three weeks of class. If you get less than 60% on any exam, please see me. If you are having trouble with this course, please come to see me during office hours or please make an appointment to see me.

Student Academic Integrity: <https://policy.unt.edu/policy/06-003>

https://policy.unt.edu/sites/default/files/06.003.AcadIntegrity.Final_.pdf

Academic Calendar 2021-2022:

<http://catalog.unt.edu/content.php?catoid=26&navoid=2783>

Division of Student Affairs: <https://studentaffairs.unt.edu/office-disability-access>

Disabilities Accommodation:

From the [unt_syllabus_template](https://clear.unt.edu/teaching-resources/unt-syllabus-template), <https://clear.unt.edu/teaching-resources/unt-syllabus-template> “The University of North Texas makes reasonable academic accommodation for students with disabilities. Students seeking reasonable accommodation must first register with the Office of Disability Access (ODA) to verify their eligibility. If a disability is verified, the ODA will provide you with a reasonable accommodation letter to be delivered to faculty to begin a private discussion regarding your specific needs in a course. You may request reasonable accommodations at any time; however, ODA notices of reasonable accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of reasonable accommodation for every semester and must meet with each faculty member prior to implementation in each class. Students are strongly encouraged to deliver letters of reasonable accommodation during faculty office hours or by appointment. Faculty members have the authority to ask students to discuss such letters during their designated office hours to protect the privacy of the student. For additional information, refer to the Office of Disability Access website (<http://www.unt.edu/oda>). You may also contact ODA by phone at (940) 565-4323.”

Disability Accommodation for Students and Academic Units:

<https://policy.unt.edu/policy/16-001>

<https://policy.unt.edu/policy/06-049>

https://policy.unt.edu/sites/default/files/06.049_Standard%20Syllabus%20Policy%20Statements_supplement.pdf

“A. Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result

in a range of academic penalties or sanctions ranging from admonition to expulsion from the University.

- B. ADA Accommodation Statement. UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding ones specific course needs. Students may request accommodations at any time, however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the ODA website at disability.unt.edu.”

In attachment of an email by the Physics Dept. Main Office: “The University of North Texas is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 92-112 The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans with Disabilities Act (ADA), pursuant to section 504 of the Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens.

<https://cos.unt.edu/>

<https://physics.unt.edu/>

Return to Learn: <https://vpaa.unt.edu/return>

1-1	W	Jan. 19	Chp. 12	Rotational Invariance and Angular Momentum
1-2	F	Jan. 21	Chp. 12	Rotational Invariance and Angular Momentum
2-3	M	Jan. 24	Chp. 12	Rotational Invariance and Angular Momentum
2-4	W	Jan. 26	Chp. 12	Rotational Invariance and Angular Momentum
2-5	F	Jan. 28	Chp. 12	Rotational Invariance and Angular Momentum
3-6	M	Jan. 31	Chp. 10	Systems with N Degrees of Freedom
3-7	W	Feb. 2	Chp. 13	The Hydrogen Atom
3-8	F	Feb. 4	Chp. 13	The Hydrogen Atom
4-9	M	Feb. 7	Chp. 13	The Hydrogen Atom
4-10	W	Feb. 9	Chp. 13	The Hydrogen Atom
4-11	F	Feb. 11	Chp. 14	Spin
5-12	M	Feb. 14	Chp. 14	Spin
5-13	W	Feb. 16	Chp. 14	Spin
5-14	F	Feb. 18	Exam 1	Chps. 10, 12, 13, & 14
6-15	M	Feb. 21	Chp. 15	Addition of Angula Momenta
6-17	W	Feb. 23	Chp. 15	Addition of Angula Momenta
6-19	F	Feb. 25	Chp. 15	Addition of Angula Momenta
7-20	M	Feb. 28	Chp. 16	Variational and WKB Methods
7-21	W	Mar. 2	Chp. 16	Variational and WKB Methods
7-22	F	Mar. 4	Chp. 16	Variational and WKB Methods
8-21	M	Mar. 7	Chp. 16	Variational and WKB Methods
8-22	W	Mar.9	Chp. 16	Variational and WKB Methods
8-23	F	Mar. 11	Chp. 16	Variational and WKB Methods

Spring Break, March 14th -18th

9-24	M	Mar. 21	Chp. 17	Time-Independent Perturbation Theory
9-25	W	Mar. 23	Chp. 17	Time-Independent Perturbation Theory
9-26	F	Mar. 25	Chp. 17	Time-Independent Perturbation Theory
10-27	M	Mar. 28	Chp. 17	Time-Independent Perturbation Theory
10-28	W	Mar. 30	Chp. 17	Time-Independent Perturbation Theory
10-29	F	Apr. 1	Exam 2	Chps. 15,16 & 17
11-30	M	Apr. 4	Chp. 18	Time-Dependent Perturbation Theory
11-31	W	Apr. 6	Chp. 18	Time-Dependent Perturbation Theory
11-32	F	Apr. 8	Chp. 18	Time-Independent Perturbation Theory
12-33	M	Apr. 11	Chp. 19	Scattering Theory
12-34	W	Apr. 13	Chp. 19	Scattering Theory
12-35	F	Apr. 15	Chp. 19	Scattering Theory
13-36	M	Apr. 18	Chp. 19	Scattering Theory
13-37	W	Apr. 20	Chp. 19	Scattering Theory
13-38	F	Apr. 22	Chp. 19	Scattering Theory
14-39	M	Apr. 25	Chp. 20	The Dirac Equation
14-40	W	Apr. 27	Chp. 20	The Dirac Equation
14-41	F	Apr. 29	Exam 3	Chps. 17, 18 & 19
15-42	M	May 2	Chp. 20	The Dirac Equation
15-43	W	May 4	Review	

Final Exam: Wednesday, May 11, 2022, 8:00 - 10:00 a.m.