Syllabus

INDIANA WESLEYAN UNIVERSITY
PHYS-505: Quantum Mechanics II – Online Asynchronous
Summer Session 1 – 5/3/22-6/27/22
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Course Description

This course will develop quantum theory and apply it to physical systems. Beginning with the fundamental experiments and phenomena, the course develops the concepts of quantum mechanics, their mathematical expression in the methods of Schrödinger and Heisenberg and the solution of problems that exhibit quantum phenomena. Use of technology for visualization is a key solution technique.

Note: This course is designed for those seeking the credentials required by many regional accrediting bodies in order to be able to teach advanced placement, concurrent early college, and community college physics courses.

Credit Hours: 3
Prerequisite Courses: PHYS-501 or equivalent (recommend PHYS-502, PHYS-503 or equivalents)
Prerequisite Skills and Knowledge: Prerequisites: a bachelor's degree with a physics major or state certification (in any state) to teach physics at a secondary school level.

Course Outcomes

Upon successful completion of this course, you should be able to:

1. Articulate a biblical worldview utilizing your attained scientific knowledge in physics.
2. Describe the key aspects of the EPR paradox, entanglement, hidden-variables theories, Bell inequalities, and quantum teleportation.
3. Relate the wave equation approach of Schrödinger and the matrix equation approach of Heisenberg to each other and to observable phenomena.
4. Apply the statistical interpretation of quantum mechanics to determine the outcomes of measurements.
5. Solve quantum mechanical problems using the wave equation approach of Schrödinger and the matrix equation approach of Heisenberg for problems in one and three dimensions and the harmonic oscillator.
6. Apply Fermi and Bose statistics to quantum mechanical systems.
7. Use technology for modeling physical systems in the quantum realm.
8. Describe how quantum mechanical principles are applied to the quantization of the electromagnetic field.
9. Model physical systems in the quantum realm using software applications (e.g., Mathematica, Maple).

Course Textbook

Griffiths, D. J. (2018). *Introduction to quantum mechanics* (3rd ed.). Cambridge, England: Cambridge University Press.

Course Technology

Each student will need to purchase a temporary site license for Mathematica Online. This can be arranged through Indiana Wesleyan.

For submitting solutions to assigned problems from the text, students may use Microsoft Equation Editor, LatEx, or another text/equation editor and submit a PDF or scans of work written on paper.

IWU Diversity Statement

IWU, in covenant with God's reconciling work and in accordance with the biblical principles of our historic Wesleyan tradition, commits to build a community that reflects Kingdom diversity.

We will foster an intentional environment for living, teaching, and learning, which exhibits honor, respect, and dignity. Acknowledging visible or invisible differences, our community authentically values each member's earthly and eternal worth. We refute ignorance and isolation and embrace deliberate and courageous engagement that exhibits Christ's commandment to love all humankind. (2016)

Grading Scale

NOTE: In graduate-level courses, a grade of C- or below will require the course to be repeated.

Grade	Quality Points Per Credit	Percentage	Score
A	4.0	95%–100%	950–1000
A-	3.7	92%–94.9%	920–949
B+	3.3	89%–91.9%	890–919
B	3.0	85%–88.9%	850–889
B-	2.7	82%–84.9%	820–849
C+	2.3	79%–81.9%	790–819
C	2.0	75%–78.9%	750–789
C-	1.7	72%–74.9%	720–749
D+	1.3	69%–71.9%	690–719
D	1.0	65%–68.9%	650–689
F	0.0	0%–64.9%	0–649

Grading Policies

Your grading policy for your course is dependent on your school and program. Your grading policies can be found in the IWU Catalog.

Letter Grade Equivalencies

NOTE: In graduate-level courses, a grade of C- or below will require the course to be repeated.

Grade	Description of Work
A	Clearly stands out as excellent performance. Has unusually sharp insights into material and initiates thoughtful questions. Sees many sides of an issue. Articulates well and writes logically and clearly. Integrates ideas previously learned from this and other disciplines. Anticipates next steps in progression of ideas. Example "A" work should be of such nature that it could be put on reserve for all cohort members to review and emulate. The "A" cohort member is, in fact, an example for others to follow.
B	Demonstrates a solid comprehension of the subject matter and always accomplishes all course requirements. Serves as an active participant and listener. Communicates orally and in writing at an acceptable level for the degree program. Work shows intuition and creativity. Example "B" work indicates good quality of performance and is given in recognition for solid work; a "B" should be considered a good grade and awarded to those who submit assignments of quality less than the exemplary work described above.
C	Quality and quantity of work in and out of class are average. Has marginal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at least minimally.
D	Quality and quantity of work are below average. Has minimal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at below-acceptable levels.
F	Quality and quantity of work are unacceptable and do not qualify the student to progress to a more advanced level of work.

Course Module Summary

Module	Optional Devotion*	Discussion*	Dropbox*	Quiz*	Total Points per Module
Module One	1/0	1/20	2/90	1/20	130
Module Two	1/0	1/20	2/80	1/20	120
Module Three	—	1/30	2/80	1/20	130
Module Four	1/0	1/20	2/90	1/20	130
Module Five	1/0	1/20	2/80	1/20	120
Module Six	1/0	1/20	1/80	1/20	120
Module Seven	—	1/30	2/100	—	130
Module Eight	1/0	1/20	1/80	1/20	120

End-of-Course Survey					10 extra credit
TOTAL	6/0	8/180	14/680	7/140	1000

* Number of Activities/Sum Point Totals

Module One Outline

Title	Type	Due Dates	Time	Points
1.1 A Promise of Success	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
1.2 Reading	Reading	Complete prior to assignments.	2 hours	0
1.3 Quantum Mechanics in Review	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
1.4 Identical Particles Application Problems	Dropbox	Due by the end of the module.	2 hours	40
1.5 Fermi and Bose Statistics Presentation	Dropbox	Due by the end of the module.	6 hours	50
1.6 Identical Particles Quiz	Quiz	Due by the end of the module.	1 hour	20
		Totals	**13:30 hours***	**130**

* These times are only estimates. Actual assignment completion times will vary.

Module Two Outline

Title	Type	Due Dates	Time	Points
2.1 A Conquering Lord	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
2.2 Reading	Reading	Complete prior to assignments.	2:30 hours	0
2.3 Symmetry	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20

2.4 Symmetry Application Problems	Dropbox	Due by the end of the module.	2 hours	40
2.5 Operators/Symmetries Tutorial	Dropbox	Due by the end of the module.	3 hours	40
2.6 Symmetries and Conversion Laws Quiz	Quiz	Due by the end of the module.	1 hour	20
		Totals	**11 hours***	**120**

* These times are only estimates. Actual assignment completion times will vary.

Module Three Outline

Title	Type	Due Dates	Time	Points
3.1 Reading	Reading	Complete prior to assignments.	2:30 hours	0
3.2 Wise Counsel	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	30
3.3 Perturbation Application Problems	Dropbox	Due by the end of the module.	2 hours	40
3.4 Experiment in Time-Independent Perturbation Theory	Dropbox	Due by the end of the module.	4 hours	40
3.5 Perturbation Quiz	Quiz	Due by the end of the module.	1 hour	20
		Totals	**11:30 hours***	**130**

* These times are only estimates. Actual assignment completion times will vary.

Module Four Outline

Title	Type	Due Dates	Time	Points
4.1 Our Supreme Example	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
4.2 Reading	Reading	Complete prior to assignments.	3 hours	0
4.3 The Variational Principle and WKB Approximation	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
4.4 The Variational Principle and WKB Approximation Application Problems	Dropbox	Due by the end of the module.	2 hours	40
4.5 Variational Principle & WKB Approximation in Everyday Life Presentation	Dropbox	Due by the end of the module.	6 hours	50
4.6 Variational Principle and WKB Approximation Quiz	Quiz	Due by the end of the module.	1 hour	20
		Totals	**14:30 hours***	**130**

* These times are only estimates. Actual assignment completion times will vary.

Module Five Outline

Title	Type	Due Dates	Time	Points
5.1 The Model Servant	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
5.2 Reading	Reading	Complete prior to assignments.	1:30 hours	0
5.3 Scattering Theory	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
5.4 Scattering Application Problems	Dropbox	Due by the end of the module.	2 hours	40
5.5 Scattering Instructional Activity	Dropbox	Due by the end of the module.	3 hours	40
5.6 Scattering Quiz	Quiz	Due by the end of the module.	1 hour	20
		Totals	**10 hours***	**120**

* These times are only estimates. Actual assignment completion times will vary.

Module Six Outline

Title	Type	Due Dates	Time	Points
6.1 Humility Demonstrated	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
6.2 Reading	Reading	Complete prior to assignments.	2 hours	0
6.3 Quantum Dynamics Presentation	Dropbox	Due by the end of the module.	8 hours	80
6.4 Quantum Dynamics Peer Review	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
6.5 Quantum Dynamics Quiz	Quiz	Due by the end of the module.	1 hour	20
		Totals	**13:30 hours***	**120**

* These times are only estimates. Actual assignment completion times will vary.

Module Seven Outline

Title	Type	Due Dates	Time	Points
7.1 Reading	Reading	Complete prior to assignments.	1 hour	0
7.2 Humility Taught	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	30
7.3 Quantum Dynamics Presentation Revised	Dropbox	Due by the end of the module.	2 hours	40
7.4 Quantum Dynamics Lesson Plan	Dropbox	Due by the end of the module.	6 hours	60
		Totals	**11 hours***	**130**

* These times are only estimates. Actual assignment completion times will vary.

Module Eight Outline

Title	Type	Due Dates	Time	Points
8.1 Humility Rewarded	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
8.2 Reading	Reading	Complete prior to assignments.	1 hour	0
8.3 Advanced Quantum Mechanics	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
8.4 Advanced Quantum Mechanics Presentation	Dropbox	Due by the end of the module.	8 hours	80
8.5 Advanced Quantum Dynamics Quiz	Quiz	Due by the end of the module.	1 hour	20
8.6 End-of-Course Survey	Quiz	Due by the end of the module.	30 minutes	10 extra credit
		Totals	**13 hours***	**120**

* These times are only estimates. Actual assignment completion times will vary.

Course Assignments

COURSE TOTAL	**98 hours***	1000

* This time is only an estimate. Actual assignment completion times will vary.

Bohm, D., & Aharonov, Y. (1957). Discussion of experimental proof for the paradox of Einstein, Rosen, and Podolsky. *Physical Review*, *108*(4), 1070–1076. doi:10.1103/physrev.108.1070

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Gross, D. J. (1996). The role of symmetry in fundamental physics. *Proceedings of the National Academy of Sciences of the United States of America*, *93*(25), 14256–14259. doi:10.1073/pnas.93.25.14256

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White, T. H. (1996). *The once and future king* (Reprint ed.). New York, NY: Ace Trade.

Winter, R. (n.d.). *Perturbation and variation*. Retrieved January 10, 2019, from http://users.aber.ac.uk/ruw/teach/237/perturb.php

Download and review the **PHYS-505 Credits Page.pdf**.

Expectations, Policies, and Important Student Information

School/Division	Link
DeVoe School of Business Division of Liberal Arts School of Services and Leadership	View School/Division Expectations, Policies, and Student Information
School of Educational Leadership	View School/Division Expectations, Policies, and Student Information
Wesley Seminary @ IWU	View School/Division Expectations, Policies, and Student Information
Nursing – Undergraduate	View School/Division Expectations, Policies, and Student Information
Nursing – Graduate	View School/Division Expectations, Policies, and Student Information