مركز الاعتماد وضمان الجودة
ACCREDITATION & QUALITY ASSURANCE CENTER

Course Syllabus

1	**Course title**	Quantum Mechanics (QM) II
2	**Course number**	(PHY 0342461)
3	**Credit hours**	3
	Contact hours (theory, practical)	(3,0)
4	**Prerequisites/corequisites**	(PHY 0342361)
5	**Program title**	B.Sc.
6	**Program code**	
7	**Awarding institution**	The University of Jordan
8	**School**	School of Science
9	**Department**	Department of Physics
10	**Course level**	Bachelor
11	**Year of study and semester(s)**	2022, Fall
12	**Other department(s) involved in teaching the course**	-
13	**Main teaching language**	English
14	**Delivery method**	☒Face to face learning ☐Blended ☐Fully online
15	**Online platforms(s)**	☐Moodle ☒Microsoft Teams ☐Skype ☐Zoom ☐Others……
16	**Issuing/Revision Date**	9/10/2022

17 Course Coordinator:

Name: Mohammad Hussein	Contact hours: S, T, Th : 10.30 – 12.30
Office number: 8	Phone number: 0775535620
Email: m.hussein@ju.edu.jo	

18 Other instructors:

Name: -
Office number:
Phone number:
Email:
Contact hours:
Name:
Office number:
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Email:
Contact hours:

19 Course Description:

This course (part II) is intended for the senior undergraduate students who have already studied part I; namely Quantum Mechanics (QM) I (PHY 361). Accordingly, the focus is on the applications and little emphasis is left on formalism (only as a brush up).

20 Course aims and outcomes:

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A- Aims:

Introductory lecture. Copenhagen interpretation.
Nondegenerate perturbation theory.
Degenerate perturbation theory.
The fine structure of Hydrogen.
The Zeeman effect and the Stark effect (Problem 7.45).
Hyperfine splitting.
Recitation sessions. Further problems for chapter 7.
The Variational principle and the Helium atom.
Recitation sessions. Further problems for chapter 8.
Scattering theory: The scattering amplitude.
Scattering theory: Partial wave technique.
Scattering theory: The Born approximation technique.
Recitation sessions. Further problems for chapter 10.
Epilogue.

B- Students Learning Outcomes (SLOs):

For purposes of mapping the course SLOs to the physics program SLOs, at the successful completion of the physics program, graduates are expected to be able to:

SLO (1) Master professionally a broad set of knowledge concerning the fundamentals in the basic areas of physics: Quantum Mechanics, Classical Mechanics, Electrostatics and Magnetism, Thermal Physics, Optics, Theory of Special Relativity, Mathematical Physics, Electronics.

SLO (2) Apply knowledge of mathematics and fundamental concepts in the basic areas of physics to identify and solve physics related problems.

SLO (3) Utilize computers and available software in both data collections and data analysis.

SLO (4) Utilize standard laboratory equipment, modern instrumentation, and classical techniques to design and conduct experiments as well as to analyze and interpret data.

SLO (5) Develop a recognition of the need and ability to engage in life-long learning.

SLO (6) Demonstrate ability to use techniques, skills, and modern scientific tools necessary for professional practice.

SLO (7) Communicate clearly and effectively in both written and oral forms.

SLO (8) Apply proficiently team-work skills and employ team-based learning strategies.

SLO (9) Apply professional and ethical responsibility to society.

21. Topic Outline and Schedule:

Attached is the syllabus which describes the topics to be covered in chronological order.

Week	Lecture	Topic	Intended Learning Outcome	Learning Methods (Face to Face/Blended/ Fully Online)	Platform	Synchronous/ Asynchronous Lecturing	Evaluation Methods	Resources
1	1.1							
	1.2							
	1.3							
2	2.1							
	2.2							
	2.3							
Week	**Lecture**	**Topic**	**Intended Learning Outcome**	**Learning Methods (Face to Face/Blended/ Fully Online)**	**Platform**	**Synchronous/ Asynchronous Lecturing**	**Evaluation Methods**	**Resources**
3	3.1							
	3.2							
	3.3							
4	4.1							
	4.2							
	4.3							
5	5.1							
	5.2							
	5.3							
6	6.1							
	6.2							
	6.3							
7	7.1							

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	7.2							
	7.3							
8	8.1							
	8.2							
	8.3							
9	9.1							
	9.2							
	9.3							
10	10.1							
	10.2							
	10.3							
11	11.1							
	11.2							
	11.3							
12	12.1							
	12.2							
	12.3							
13	13.1							
	13.2							
	13.3							
14	14.1							
	14.2							
	14.3							
15	15.1							
	15.2							
	15.3							

22 Evaluation Methods:

Opportunities to demonstrate achievement of the SLOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	SLOs	Period (Week)	Platform
First Exam	30	Chapter 7	1	8th Week	On campus
Second Exam	20	Chapter 8	2	13th Week	On campus
Final Exam	50	Chapters 7,8,9	1,2,3	16th Week	On campus

23 Course Requirements

Students are directed and encouraged to use all possible resources:
a) use the internet as a learning source.
b) a series of short movies is promoted
c) students are encouraged to learn a suitable software package as a learning tool.

24 Course Policies:

A- Attendance policies:

No more than 15% of classes can be missed under any circumstances. The students are supposed to be on time for each session and will not be admitted after 10 minutes from the starting time.

B- Absences from exams and submitting assignments on time:

Assignments are only taken if submitted on time and no make ups for short quizzes.

C- Health and safety procedures:

The lectures are located in proper locations for best lecturing conditions.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

Any act of cheating or plagiarism is not tolerated and the students are clearly required to submit their own work.

E- Grading policy:

The grading for this course is divided into: 50 % midterm exams, and 50% final exam.

F- Available university services that support achievement in the course:

A proper library and well-furnished lab.

25 References:

A- Required book(s), assigned reading and audio-visuals:

Introduction to Quantum Mechanics, by David Griffiths & Darrell Schroeter, 3rd edition, Cambridge University Press 2018, ISBN 978-1-107-18963-8 Hardback.

B- Recommended books, materials, and media:

- References: any introductory book on a level comparable to our textbook. Recommended titles (among others): Introductory QM by Liboff, Quantum Physics by Gasiorowicz, Elementary QM by Saxon, and Introduction to QM by Dicke and Wittke.
- Self-reading titles: Quantum physics for poets, by Leon Lederman and Christopher Hill, 2011, Prometheus Books. Foundations of Quantum Mechanics, by Travis Norsen, 2017, Springer. How to Understand Quantum Mechanics, by John Ralston, 2017, IOP. Understanding QM, by Roland Omnes, 1999, Princeton University press. The interpretation of QM, by Roland Omnes, 1994, Princeton series in physics. Quantum physics: Illusion or reality? By Alastair Rae, 2004, Cambridge University press. Quantum: Einstein, Bohr and the great debate about the nature of reality, by Manjit Kumar, 2009, Icon Books Ltd.

26 Additional information:

Name of Course Coordinator: **Mohammad Hussein** ---Signature: *Mohd Hussein*-- Date: **October 9, 2022**----------
Head of Curriculum Committee/Department: ---------- Signature: ----------
Head of Department: ---------- Signature: ----------
Head of Curriculum Committee/Faculty: ---------- Signature: ----------
Dean: ---------- Signature: ----------

Quantum Mechanics (QM) II (PHY 461) – Fall semester, 2022

- Instructor: Mohammad Hussein.
- This course (part II) is intended for the senior undergraduate students who have already studied part I; namely Quantum Mechanics (QM) I (PHY 361). Accordingly, the focus is on the applications and little emphasis is left on formalism (only as a brush up).
- Required textbook: Introduction to Quantum Mechanics, by David Griffiths & Darrell Schroeter, 3rd edition, Cambridge University Press 2018, ISBN 978-1-107-18963-8 Hardback.
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- Grading: Two mid-term exams (both will count 50% of the cumulative grade) and final comprehensive exam (counts 50% of the cumulative grade).
- The content of the lectures below describes what is planned for the lectures and where you can read more about the material. The content is subject to change depending on how

things go. **[G-QM-1]**: Griffiths - QM 1st edition. **[G-QM-2]**: Griffiths - QM 2nd edition. **[G-QM-3]**: our textbook. **[B]**: Boas - Mathematical Physics 3rd edition.

- Topics to be covered in chronological order:

Lecture	Section	Theme	Digression	Problem-solving application
10/10/2022	-	Introductory lecture: The Copenhagen interpretation & the meaning of quantization. In **[G-QM-1]** on page 26 right after equation 2.23, Griffiths used the wording (In *sharp* contrast to the classical case …), while in the **[G-QM-2]** on page 32 right after equation 2.27 and similarly in **[G-QM-3]** on page 32 right after equation 2.30, he used the wording (In *radical* contrast to the classical case …)!		
12/10/2022	7.1.1	Exact vs perturbative solution.	-Problem 2.44: no degeneracy in 1D. -Hermitian operator.	-P.3.4 & P.3.5. -Verify Eq. 4.85 and do P.4.46. -Check page 429 right after Eq. 11.91.
17/10/2022	7.1.2	1st order correction to the energy.	Hilbert space: Eq. 3.11. Examples: [Eqs.2.31, 2.35, 2.68 & 2.86].	Compare Ex.7.1 with P.9.1 of the WKB technique!
19/10/2022	7.1.2	1st order correction to the wave function.	Closure: Eqs.3.93 – 3.96.	P.7.1.
24/10/2022	7.1.3	2nd order correction.	Virial theorem: P3.37. & Ex.2.5.	P. 7.5(a).
26/10/2022	7.1.3	2nd order correction (cont.)	-	P.7.2 & P.7.5(b).
31/10/2022	7.2.1	Two-fold degenerate perturbation.	-Compatible operators. -Consult **[B]** Sec.3.11	Verify the null vector: page 96 & Appendix A.1: Eq.A.4 & Eq.A.10.
2/11/2022	7.2.2	Good states.	-Parity operator: Sec.6.4. -Bloch's theorem: Sec.5.3.2	P.7.9 & P.2.46.
7/11/2022	7.2.3	Higher order degeneracy.	Permutation operator: Sec. 5.1.4	P.7.11 & P.7.12.
9/11/2022	-	-1- Stark effect (through P.7.6). Sec.6.8 & **[G-QM-2]** P.3.39 -2- Stark effect (through P.7.45)	-1- P. 4.1, P.4.15 & P.4.22. -2- Selection rules: Sec.6.7.2 & Sec.6.4.3.	-1- Use P. 4.22 and consult **[G-QM-2**: P.9.12**]** to solve P.6.19 -2- P.7.46.

14/11/2022	7.3	-1- Hierarchy of corrections to the Bohr energies of the hydrogen atom. -2- Estimating ground-state energy of the hydrogen atom using the uncertainty principle.	-1- Why is ($\alpha/2\pi$) engraved above Schwinger's name on his tombstone? Sec.4.2: brush up. -2- Planck length. The failure of Rutherford model; the planetary model is doomed.	-P.7.14. -P.5.1 & P.5.2.
16/11/2022	7.3.1	The relativistic correction.	Virial theorem: P.4.48.	P.7.15, P.7.17 & P.7.42
21/11/2022	7.3.2	The spin-orbit coupling.	-The g-2 measurements. -P.4.64 (brush up)	P.7.19, P.7.20 & P.7.22.
23/11/2022	7.4 & 7.5	The Zeeman effect & Hyperfine structure: Rule of thumb.	-	P.7.26.
28/11/2022	**First Exam: This is a closed-book exam covers all the materials of chapter 7. The answer key will be provided right after the end of the exam.**			
30/11/2022	8.1	The Variational principle. Compare footnote 19 on page 36 with footnote 18 on page 103!	Gaussian integrals: P.2.21.	-
5/12/2022	8.1	The Variational principle (cont.)	Step function & Delta function: P.2.23 & P.2.24.	-Ex.8.3 vs P.8.3 & P.8.2 vs P.8.18. -P.8.19 & P.8.21.
7/12/2022	8.2	-The ground state of Helium. -The screening effect.	Sec.5.2.1: brush up & P.4.19.	-
12/12/2022	8.2	The ground state of Helium (cont.).	Anti-screening in QCD.	P.8.7 & P.5.15.
14/12/2022	10.1	The scattering amplitude.	-	-
19/12/2022	10.1	The scattering amplitude (cont.).		P.10.2 & P.2.53.
21/11/2022	10.2	Partial wave technique.	-Table 4.4. -Consult **[B]** Sec. 12.17.	-
26/12/2022	10.2	Partial wave technique (cont.).	-	P.10.4.
28/12/2022	10.3	Phase shifts.	-	-
2/1/2023	**Second Exam: This is a closed-book exam covers all the materials of chapter 8. The answer key will be provided right after the end of the exam.**			
4/1/2023	10.3	Phase shifts (cont.).	-	P.10.5 & P.10.6.
9/1/2023	10.4	The Born approximation technique.	Consult **[B]** Sec.14.3.	-

11/1/2023	10.4	The Born approximation technique (cont.).	-	P.10.10 & P.10.13.
16/1/2023	10.4	-The Born approximation technique (cont.). -Epilogue.	-	Yukawa potential: [Ex.10.5, P10.11 & P.10.12] vs Gaussian potential [P.10.20].
22/1/2023	**Final Exam: This is a closed-book comprehensive exam covers all the materials of the course.**			