

## **COURSE SYLLABUS FORM**

American University of Beirut  
Faculty of Arts and Sciences

Department: **Physics**

Course Number and Title: **Phys 236, Quantum Mechanics**

### **1. Course Learning Outcomes**

This senior-standing course presents a “Modern Approach to Quantum Mechanics”. This means that it describes the concept of quantum mechanics directly in Hilbert Space as being the natural domain of developing this powerful theory . To say it in other words, the student will experience quantum mechanics as operator theory . In addition the student should realize that quantum mechanics is more than a physical theory, it is a theory of provocative implications and a great intellectual achievement and adventure.

In particular, the student should:

- Deal with the formalism of quantum mechanics and associate physical observable with Hermitian Operators. Realize operators can be represented by matrices for which one seeks eigenvalues and eigenvectors.
- Learn the properties of the Rotation operator, the Hamilton operator as time evolution operator and the momentum operator as translation operator.
- Comprehend how measurements are interpreted in quantum mechanics.
- Receive intensive training in the study of quantum systems in different situations: time evolution , solving the Schroedinger equation in one and three dimensions for different potentials.
- Understand the basic concept of the time-independent perturbation theory and its application to physical situations.
- Follow the basic concept of scattering theory

### **2. Resources available to the students**

Main text book: A modern Approach to Quantum Mechanics

By J. S. Townsend

McGraw Hill, Inc

Other text books:

Quantum Mechanics

By R. Robinett

Oxford University Press, 1997

Quantum Physics

By S. Gasiorowicz

John Wiley & Sons, 1996 2th edition

Modern Quantum Mechanics

By J.J Sakurai (S.F. Tuan, editor)

Addison-Weseley, 1994

### **3. Grading Criteria**

The final grade is based on the performance in 2 exams during the semester, each of a weight of 25%, and a comprehensive final exam of a weight of 40%, and 10% are given for homework.

### **4. Schedule**

Week	Topic	Assignments
1-2	Stern-Gerlach Experiments: Quantization of the electron spin. Probability Amplitude. Quantum State Vector. Operators and their Matrix Representations. What is the meaning of Measurements.	Homework problems
3	Matrix Mechanics: The Rotation Operator. The identity And Projection operators. Changing representation by Similarity Transformation.	Homework problems. Presentation of selected examples by the students
4 -5	Angular Momentum: Eigenvalues and Egenvectors of the Angular Momentum. Density Operator, Pure and Mixed states. Spin-1/2 Eigenvalue problem. Spin-1 Particles	Homework problems. Presentation of selected examples by the students
6 -7	Time Evolution: Hamilton Operator and its Significance. Spin-1/2 Particle in a Magnetic Field. Magnetic Resonance	Homework problems. Presentation of selected examples by the students
8	Two-Spin -1/2 Particles: Basis States. Hyperfine Splitting, Addition of Spins. Singlet and Triplet States.	Homework problems

9	Wave Mechanics in One-Dimension Translation and Momentum Operators. Wave Packets. Uncertainty Principle. Schroedinger Equation. Scattering in One Dimension. Tunnel Effect.	Homework problems Presentation of selected examples by the students
10	One-Dimensional Harmonic Oscillator: Creation and Destruction Operators and their use to study the properties of the Harmonic Oscillator.	Homework problems Presentation of selected examples by the students
11	Translational and Rotational Symmetry: Radial Wave Equation. Coulomb Potential. And the Hydrogen Atom. Bound States of the Deuterium. Three- dimensional Isotropic Oscillator.	Homework problems Presentation of selected examples by the students
12-13	Time-independent Perturbation Theory: Non-degenerate Perturbation, Degenerate Perturbation. Examples: Molecules in a weak electric field	Homework problems Presentation of selected examples by the students
14	Elements of Scattering theory: Differential Cross section. Basic Description of Scattering. Born Approximation. Partial Wave Analysis. Examples.	Homework problems

### **5. Course Policy**

Regular attendance. No make up of the quizzes. Make up of any exam only with legal justified reasons. Cheating in the exams is prohibited and can lead to expelling the student from the course.