

– Master of Science Programme in Physics of Complex Systems – Advanced Quantum Mechanics

Angelo Rosa* and Davide Marcato†

SISSA - Scuola Internazionale Superiore di Studi Avanzati, Via Bonomea 265, 34136 Trieste (Italy)

(Dated: July 21, 2023)

Aim of the course. The course aims to provide a thorough introduction to more advanced concepts of quantum mechanics and to discuss several applications of it.

Expected learning outcomes. The students will develop a deep understanding of a few special topics of advanced nature: the propagator and the formulation of quantum mechanics with the Feynman path integral; identical particles; particles in periodic potentials and band structure in solids.

Prerequisites. Some prerequisites of QM (see the topics of the course *Introduction to Quantum Mechanics*) are indispensable.

Delivery modes. Frontal lectures, including problems sessions on several applications of quantum mechanics.

Assessment and grading criteria. The examination will be based on 1 written test and an oral test. The final mark is provided by the average of the written (50%) and oral (50%) parts.

Suggested references. (1) J. J. Sakurai, *Modern Quantum Mechanics* (Addison-Wesley); (2) R. Shankar, *Principles of Quantum Mechanics* (Plenum Press); (3) P. A. M. Dirac, *The Principles of Quantum Mechanics* (Oxford University Press); (4) L. E. Picasso, *Lectures in Quantum Mechanics* (Springer International Publishing); (5) E. d’Emilio, L. E. Picasso, *Problems in Quantum Mechanics: with Solutions* (Springer International Publishing).

CONTENTS

- | | |
|---|---|
| I. Definition of the Propagator and Formulation of Quantum Mechanics Using Path Integrals | V. Identical Particles in Quantum Mechanics |
| II. Variational Techniques: Applications to Time-Dependent Problems | VI. Symmetries in Quantum Mechanics |
| III. Time-Independent & Time-Dependent Perturbation Theories | VII. Particles in Periodic Potentials: Bloch’s Theorem & Band Structure |
| IV. Scattering Theory | VIII. Particles in Periodic Potentials: Approximations & Examples |
| | IX. The Density Operator |

* anrosa@sissa.it

† dmarcato@sissa.it