연세대학교
YONSEI UNIVERSITY

IBM Quantum Learning Course Guide

From Quantum mechanics to
Quantum diagonalization algorithms

Hyungmin Lim

School of Engineering
Department of Electrical Engineering
Bachelor in Science

South Korea, July 2025

연세대학교
YONSEI UNIVERSITY

IBM Quantum Learning Course Guide

From Quantum mechanics to Quantum diagonalization algorithms

Hyungmin Lim
Student No. 2022142207

Supervisor: Chaeyeon Park
Assistant Professor, Yonsei University

School of Engineering
Department of Electrical Engineering
Bachelor in Science

Club Activity/QIYA/IBM Learning Course

South Korea, July 2025

IBM Quantum Learning Course Guide

Preparation of this work was facilitated by the use of the *IPLeiria-Thesis* template.

Acknowledgements

I would like to express my deepest gratitude to Professor Chaeyeon Park, whose guidance and encouragement were invaluable throughout the preparation of this project. Her insights and unwavering support made this work possible.

I am also sincerely thankful to Junseok Jung, a graduate student whose thoughtful advice and expertise provided me with both technical direction and motivation during the development process.

Special thanks go to my close friends and collaborators, Seokwon Choi and Jungbin Ho, for their active participation in discussions and their companionship throughout the IBM Quantum Learning Course. Their presence made this journey both intellectually rewarding and personally meaningful.

Finally, I would like to acknowledge the organizers and contributors of the IBM Quantum Learning Course, whose efforts in designing and delivering the program laid the foundation for this project. Their dedication to advancing quantum education was a true inspiration.

Abstract

This guide is intended for those who are beginning their study of quantum information and its implementation using Qiskit. It is originally based on the IBM Learning Course. The document primarily covers seven modules from the course: Quantum Mechanics, Computer Science, Basics of Quantum Information, Fundamentals of Quantum Algorithms, General Formulation of Quantum Information, Foundations of Quantum Error Correction, Quantum Computing in Practice, and Quantum Chemistry with VQE and Quantum Diagonalization Algorithms. Each topic is grounded in deep mathematical and technical foundations, but the IBM course is designed to be accessible to general audiences. This guide aims to elaborate on the content of these modules and provide detailed explanations and answers to the accompanying discussion problems.

Keywords: Quantum Information Basics, Quantum Algorithm Basics.

Contents

List of Figures

List of Tables

1 Qiskit in Classrooms: Quantum Mechanics

Author: Hyungmin Lim
Current Version: 0.0.1
License: LaTeX Project Public License v1.3c
Official Repository: GitHub Repository

Welcome to the *IBM Quantum Learning Course Guide*!

1.1 Superposition with Qiskit

In this section, we will find out the one of the most important quantum phenomenon-superposition. Through

1.2 Stern-Gelach measurements with Qiskit

1.2.1 Introduction

1.2.2 Classical coin

1.2.3 Quantum coin

1.2.4 The quantum revealed: an experiment in three dimensions

1.2.5 The quantum phase

1.2.6 Bloch sphere representation

Blochsphere examples

Hello my freinds

1.3 Exploring uncertainty with Qiskit

1.4 Bell's inequality with Qiskit