

MATH 231: CALCULUS II, HONORS PROJECT QUANTUM DYNAMICS IN ONE DIMENSION

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Quantum mechanics, birthed in the early twentieth century due to the likes of Max Planck, Max Born, Wolfgang Pauli, Werner Heisenberg, and Erwin Schrödinger, remains the basis for contemporary physical theories. By describing how the *wavefunction* ψ of a system evolves in time t , the Schrödinger equation

$$i\hbar \frac{\partial}{\partial t} \psi = \hat{H} \psi$$

dictates the dynamics of quantum systems. While explicitly solving the equation is plainly impossible in most situations, some setups in spatial dimension one can be tackled solely using the tools of Math 231. In this honors project, we will solve the Schrödinger equation for the quantum dynamics of a single particle subjected to different choices of potential energy function. Along the way, we will utilize (improper) integration, Taylor series, and more.

How will we approach this material? There will be guided worksheets (labeled HP n in the schedule below), designed to be worked through like your usual discussion worksheets, that lead you through both the prerequisites for and the solutions to the different quantum problems. These will be due by email to Dheeran, and will be assessed on “good faith” attempts. We will also have semi-regular meetings (to be scheduled via email, based on availability) in which you can ask questions and discuss the material with your peers.

You will also be responsible for preparing a final talk (slides and an in-person presentation) describing one aspect of quantum mechanics covered on our worksheets, and any prerequisites to understand it. This should be done at a level where your Calculus II peers could reasonably follow along and understand.

Week	Topic	Task
0	States, Evolutions, and Some History	Attend Lecture
1	Introduction to the Schrödinger Equation	Do HP01
1	Introduction to the Schrödinger Equation	Make INTRODUCTION Slides
2	A Particle in a Box	Do HP02
2	A Particle in a Box	Make INTRODUCTION Slides
3	Tunneling Through a Barrier	Do HP03
3	Tunneling Through a Barrier	* Slides
4	Quantum Expectation Values	Do HP04
4	Quantum Expectation Values	* Slides
5	The Harmonic Oscillator	Do HP05
5	The Harmonic Oscillator	* Slides
6	Wrap Up	Finish Slides

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