# Quantum Mechanics: Class Topics

Class topics and problem assignments for Oberlin College's Physics 312: Quantum Mechanics, as offered by Dan Styer in Spring 1990.

| | topic | problems assigned |
|---|---|---|
| | **Conceptual foundations** | |
| 1. | Why do we need a quantum mechanics? | 3.1, 3.2 |
| 2. | The conundrum of projections | |
| 3. | What is a quantal state? | 1.1–1.6 |
| 4. | Interference | |
| 5. | Entanglement and EPR | |
| | **Forging mathematical tools for quantum mechanics** | |
| 6. | Working with amplitudes | 1.7, 2.1–2.4, 3.3 |
| 7. | How to specify a quantal state | |
| 8. | Outer products, operators, measurement | |
| 9. | Linear algebra | Gillespie |
| | **Time evolution** | |
| 10. | Time development and the time development operator | |
| 11. | Working with the Schrödinger equation | |
| 12. | The Ammonia Maser | exam 1 |
| 13. | Formal properties of time evolution | |
| | **Continuum systems** | |
| 14. | Describing states in continuum systems | |
| 15. | Ansatz for the Hamiltonian in one-dimensional potential problems | 6.1–6.5 |
| 16. | Operators and their representations: the momentum basis | |
| 17. | Time evolution of average quantities; The classical limit | |
| 18. | Free particle motion | 7.1–7.5 |
| 19. | The visualization of quantal wavepackets | |

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|---|---|---|
| | **Simple harmonic oscillator** | |
| 20. | Energy eigenproblem through differential equation | |
| 21. | Energy eigenproblem through operator factorization | 4.1–4.3, 8.1–8.3 |
| 22. | Time evolution in the SHO | |
| | **Perturbation theory** | |
| 23. | Perturbation theory for cubic equations | |
| 24. | Perturbation theory for the energy eigenproblem | 9.1, 9.2, 9.4, 9.5, 10.1 |
| 25. | Perturbation theory for the time development problem | |
| | **Angular momentum** | |
| 26. | Quantum mechanics in three dimensions | |
| 27. | Angular momentum and rotations | exam 2 |
| 28. | Solution of the angular momentum eigenproblem | |
| 29. | Miscellaneous angular momentum topics | |
| 30. | Angular momentum projected on various axes | 11.1, 11.2, 11.4 |
| | **Central force motion** | |
| 31. | Examples and the two-dimensional case | |
| 32. | Central force motion in three dimensions | |
| 33. | Angular momentum and the central force problem | 12.1, 12.2, 12.3 |
| 34. | The Coulomb problem | |
| 35. | Hydrogen atom fine structure | |
| | **Identical particles** | |
| 36. | States of identical particles | 13.1–13.3 |
| 37. | Basis states for identical particles | |
| 38. | Building basis states; Helium | |
| | **Conceptual foundations** | |
| 39. | Quantal motion as a sum over classical paths | 14.1 |

Topics discussed informally in conference sessions:

What is “physical reality”, what is “mathematical tool”?
Practical matrix diagonalization
Algorithmic solution of the time development problem by time stepping
Dimensional analysis
Motion of wavepackets by the method of stationary phase
Transition probabilities, spontaneous emission, coupling of atoms to the electromagnetic field (qualitative)
Why there is no “time operator” in relativistic quantum mechanics
Relativistic quantum mechanics: field character of particles, particle character of fields
Addition of angular momenta (Clebsch-Gordon coefficients)
Spherical harmonics via group theory (this went over poorly!)
Occupation number representation — second quantization (this also went poorly)
The Aharonov-Bohm effect