QUANTUM MECHANICS II (PHYS 501) Jan-April 2026

Lecturer: PCE Stamp https://phas.ubc.ca/~stamp/TEACHING/index.html

Here is an over-complete guide to the course (we can't do all of this!). What I actually teach, and at what level, will be partly determined by the background and interests of the students. There is no set book – but many books and articles can be used as background reading (see list below). The course notes will form the basis of the course. I'll include many examples from different fields of physics.

(1) BASICS - CONCEPTUAL

Entanglement, non-locality, Bell states, 2-path experiments. EPR paradox. Delayed choice and quantum eraser experiments.
State preparations and measurements. Non-local measurements, weak measurements
Decoherence and disentanglement; the quantum environment.
What is "real" in quantum mechanics – different views and interpretations, and paradoxes

(2) BASICS - FORMAL

Classical Physics: Hamiltonians, Lagrangians, & Symmetries
Wave-functions and density matrices. Reduced density matrices
Path integrals for particles and for spin. The bridge to quantum field theory.

(3) STATISTICS

Statistics – fermions, bosons, & anyons. 2^{nd} quantization & Coherent states

(4) PERTURBATION THEORY

Time-independent theory: expansion in small parameter; diagrammatic representations
Scattering theory: Born approximation, S-matrix & T-matrix; Resonant scattering, bound states
Time-dependent perturbation theory – convergent & divergent expansions

(5) SEMICLASSICAL APPROXIMATIONS

Classical & Quantum orbits; trace formulae; quantum chaos
Tunneling, and other non-perturbative effects; spin tunneling & topological phase

(6) QUANTUM INFORMATION & QUANTUM COMPUTING

Bell states revisited. GHZ states. Separability and quantum teleportation.
QBits & CBits. The Feynman computer. Gate Q computation. Adiabatic Q computation
Grover and Shor algorithms. Q cryptography & Q communication
Errors and Decoherence. Q Error correction.
Q computation – current progress (theory, experiment, and industry).

SOME USEFUL BOOKS (There are many more)

F Laloe "Do we really understand Quantum Mechanics?"
J.S. Bell "Speakable & Unspeakable in Quantum Mechanics"
AB Migdal "Qualitative Methods in Quantum Theory"
RP Feynman AR Hibbs "Quantum Mechanics & Path Integrals"
LS Schulman "Techniques & Applications of Path Integrals"
N.D. Mermin "Quantum Computer Science: an Intro"
M.A. Nielsen, I.L. Chuang "Quantum Computation & Quantum Information"