

OPTICAL PHYSICS QUALIFYING EXAM TOPICS

version 2022.09.21

Listed below are the primary topics from OPTI 511R that also have overlap with OPTI 570 and OPTI 544. These are the main topics that will be available for questioning on the PhD Qualifying Exam beginning Fall 2023. Optical resonators and laser physics will no longer be covered on the qualifying exam beginning Fall 2023.

1. postulates of quantum mechanics
2. wavefunctions – interpretation, sketching, physically acceptable wave functions, normalization, orthonormality, probability density distributions, stationary states, position and momentum representations and Fourier transforms, uncertainty relations
3. calculating expectation values and probabilities
4. superpositions of energy eigenstates, and their time dependence
5. free-particle wave functions and wave packets
6. infinite square well – energy eigenfunctions and eigenvalues
7. harmonic oscillator (energy eigenfunctions and eigenvalues, raising and lowering operators)
8. hydrogen atom (spinless electron and proton model) – Coulomb potential, energy levels and energy eigenvalues, spherical harmonics and electron orbital angular momentum, quantum numbers, kets that indicate the quantum numbers of energy eigenstates
9. 2-level systems, spin-1/2 problem – spin-1/2 particle in a magnetic field, Stern-Gerlach
10. Rabi oscillations
11. basics of light-matter interaction – Electric dipole interaction, single-photon transitions especially between hydrogen atom energy eigenstates, dipole matrix elements, selection rules
13. photon number states, photon annihilation and creation operators