

# OPTI 511R- Optical Physics and Lasers

## Course Description:

Fundamental concepts of quantum mechanics; applications to model quantum systems; interaction of light with atoms; two-level atom approximation; fundamental concepts of laser operation. Prerequisite: OPTI 501.

## Outline

### Optical Physics:

1. Introduction to quantum mechanics, wave/particle duality, uncertainty principle
2. Quantum mechanics of free and bound particles, wave packets
3. Schrodinger equation, wave functions, eigenvalue equations
4. Postulates of quantum mechanics
5. Measurements in quantum mechanics, expectation values
6. Quantum harmonic oscillator
7. Hydrogen atom, quantum mechanics of the real hydrogen atom
8. Dirac notation, matrix formulation of quantum mechanics
9. Spin angular momentum, Pauli exclusion principle
10. Hamiltonian for light/matter interaction, time-dependent probability amplitudes
11. Electric dipole approximation, Rotating wave approximation
12. Two-level atom approximation, Rabi oscillations
13. Collisional decay and spontaneous emission, rate equations
14. Blackbody radiation, Einstein A and B coefficients
15. Steady-state absorption coefficient, saturation
16. Inhomogeneous line broadening, absorption lineshapes
17. Quantization of the electromagnetic field, vacuum field fluctuations
18. Photon statistics

### Lasers:

19. Optical resonators, resonator stability
20. Population inversion
21. Threshold gain and steady-state laser operation
22. Laser output characteristics and output control
23. Pulsed lasers, Q-switching, mode locking