Physics 511
Laser Physics Tentative Syllabus

Text: Laser Electronics by J.T. Verdeyn.
Pre-requisites: Physics 322 (Optics) and Physics 342 (Modern Physics).

Laser Physics is a course about the physics of lasers; how laser work. Because the physics of lasers crosses boundaries such as optics and atomic and molecular physics we will have to cover small parts of each of these topics. In particular, to learn about cavities we have to have some understanding resonators and geometric optics and Gaussian beams. To understand optical amplification we must understand the interaction of light with matter and be able to interpret rate equations. From the rate equations we will be able to determine population inversions and cavity and excitation rate requirements. Nonlinear optics will be introduced when we discuss about frequency doubling and parametric oscillators

Topics covered

- Laser light
- Stimulated emission
- Optical beams and resonators
- Ray and wave optics, Gaussian beams
- Laser dynamics, oscillation threshold conditions
- Beam perturbation, diffraction
- Resonator stability, ABCD matrix
- Cavity Modes
- Unstable resonators
- Laser spiking and mode competition
- Q-switching and mode-locking
- Injection locking
- Spatial hole burning
- Gain saturation
- Frequency doubling, phase conjugation and parametric oscillators

Grading: Undergraduates: There will be two take home exams and a final. The exams will be weighted 15% each and the final will be weighted 20%. The remaining 50% of the grade will be determined through 8 homework assignments.

Graduates: There will be two take home exams and a final. The exams will be weighted 10% each and the final will be weighted 20%. 30% of the grade will be determined through 15 homework assignments and 20% of the grade will be on a research paper examining some aspect of lasers or the use of lasers.