Physics 5320/8220 – Fundamentals of Photonics Spring 2011

Instructor: Cass Sackett **email**: sackett@virginia.edu
Office: Phys 155 **Phone**: 924-6795

Phys 5320/8220 is intended to explain how lasers work and to describe some of the optical techniques used with laser beams. This material is important for many disciplines, including physics, astronomy, engineering, chemistry and biology. We will have students from several different departments at both the graduate and undergraduate level. It will be important for everyone to be aware of the range of backgrounds present, and to ask questions about unfamiliar material when necessary.

The division between 5320 and 8220 is also meant to help handle the variation in background preparation. Physics graduate students should enroll in 8220, and other students should enroll in 5320. Exceptions to this policy should be cleared with me. Students in 8220 will be graded separately and will also be given some additional homework problems that rely on physical and mathematical topics outside of those covered in class.

Class Hours (Room): MW 1:00 – 1:50 PM (Physics 218), F 11:00-11:50 (Physics 313)
Office Hours: Thursday 3-5 PM and by appointment

Homework will be due weekly on Fridays.

Webpage: http://people.virginia.edu/~cas8m/classes/phys5320
Lecture notes, homework assignments, and solution sets will be posted here.

Text: Saleh and Teich, *Fundamentals of Photonics (2nd Edition)*
I expect that the 1st Edition will also suffice.

Supplemental texts: (on reserve in Physics Library)
Yariv – *Quantum Electronics* (general photonics, more advanced)
Milonni and Eberly – *Lasers* (more detailed discussion of lasers)
Seigman – *Lasers* (good physical explanations, also advanced topics)
Hecht – *Optics* (optics fundamentals)
Klein and Furtak – *Optics* (optics fundamentals)
Boyd – *Nonlinear Optics* (more detailed treatment of nonlinear optics)

Prerequisites:
Nominally, Phys 5310 Optics is a prerequisite for this class. Nonetheless, students who have not taken optics should be able to succeed in Phys 5320, since we will review results from optics as required. However, all students should be familiar with electromagnetism (including Maxwell's equations) at the level of a calculus-based introductory course. In addition, students should be familiar with the mathematics of calculus, ordinary differential equations, vectors, matrices, complex numbers, and basic Fourier transform theory.

Topics (book chapters):

I. Laser Beams – ray matrices, Gaussian beams, optical resonators (1, 3, 10)
II. Laser Theory – light and matter, optical amplification, laser oscillation (13, 14, 15)
III. Lasers Survey – solid, liquid, gas, diode, free electron lasers (15, 16, 17)
IV. Modulation Techniques – electro-optic, acousto-optic (19, 20)
V. Nonlinear Optics – second and third order, phase matching techniques (21)
VI. Fiber optics – fiber modes, fiber communication techniques (9, 23, 24)

Grading:

Homework	50%
Midterm exam	20%
Final exam	30%

Your lowest homework score will be dropped if you complete the course evaluation form at the end of the semester.

Assignments are due at the start of class on the day specified. Late assignments will be assessed a 10% penalty if received before the solutions are posted to the course website. (Solutions will typically be posted four or five days after due date.) Later assignments may still be accepted at the discretion of the instructor, but will generally be assessed a larger penalty.

Exams:

There will be a midterm and a final exam. The midterm will be take-home, and will be held over the week of February 28 to March 4. The final will be held in class on Friday, May 6 from 2:00 to 5:00 PM.