Classical Optics

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Prerequisites: Optics, E&M or Graduate Students

Lectures: Tuesday and Thursday 3:10 PM-5:00 PM

Office hours: Wednesday 10:30 AM-11:30 AM or by appointment (send me an email)

E-mail: sundong@pku.edu.cn

Textbook:
None required. All required reading selections will be posted on the web.

Supplementary References:
R. Guenther, *Modern Optics* (Wiley)
M. Born and E. Wolf, *Principles of Optics* (Cambridge, 7th edition)
G. Booker, *Modern Classical Optics* (Oxford)
E. Hecht, *Optics* (Addison Wesley, 2nd edition)
Lipson, Lipson, and Tannhauser, *Optical Physics* (Cambridge)
A. Siegman, *Lasers* (University Science Books)
H. Haus, *Fields and Waves in Optoelectronics* ((Prentice Hall)
J.D. Jackson, *Classical Electrodynamics* (Wiley)
M. Young, *Optics and Lasers* (Springer-Verlag)
K. Iizuka, *Engineering Optics* (Springer-Verlag)
W. Lauterborn, T. Kurz, and M. Wiesenfeldt, *Coherent Optics* (Springer)
L. Mandel and E. Wolf, *Coherence and Quantum Optics*, (Cambridge)
G. Fowles, *Introduction to Modern Optics* (Dover, 2nd edition)
M. Minneart, *Light and Color in the Outdoors* (Springer 1993)
K. Moller, *Optics* (University Science Books)
C. Pollock, *Fundamentals of Optoelectronics* (Irwin, 1995)

Course Website:
Information and course materials will be posted on website:
www.phy.pku.edu.cn/~sundong/Teaching.htm

This will include copies of the lecture notes, homework assignments, assigned reading materials (journal articles and relevant sections from the supplementary references in pdf format), and announcements.
The web site is a supplement to the class; you are responsible for all material presented in class whether or not it appears on the web site.

Course Objectives:
This course will introduce classical optics from first principles at a first-year graduate level. The theory of electromagnetic, geometric, and physical optics is systematically presented, and forms the base for further study in guided wave optics, electro- and acoustic-optics, nonlinear optics, lasers, and quantum optics.

Grades:
Homework 15%
Exam 1(Open book, written) 40%
Exam 2(Open book, written) 45%

Homework:
The homework is an essential part of the course. You should attempt all the problems yourself, but you may argue with your colleagues about the basic ideas underlying the problems. (Simply copying each other's solutions is, however, counterproductive for all parties, and contrary to the honor code.) In addition, each problem will have one student assigned to write up a "textbook" solution to go on reserve. These solutions should go beyond the usual homework solution, in that special care should be given to the presentation and discussion of the logic of the solution. The reserve solutions should be typed, or at least very carefully handwritten, and correct! In science, the communication of arguments and results is nearly as important as the results themselves, so this should be good practice. (Also, each of your reserve solutions will be scored on a scale of 0-10 and included in your final grade calculation.) Homework solutions will be posted on the course web site.

Course Outline (hours: 58 total)
1. Electromagnetic Theory (10)
   a. Maxwell's equations (1)
   b. Energy density and flow (1)
   c. Reflection and refraction at boundaries(2)
   d. Modes in dielectric waveguides(2)
   e. Modes in step-index optical fibers(2)
   f. General mode problem(2)

2. Classical Dispersion (14)
   a. Dipole radiation (2)
   b. Lorentz atom (2)
   c. Index of refraction & Sellmeier's equation(2)
   d. Resonant absorption and dispersion(2)
   e. Optics of metals & plasmons; nanoparticles(2)
   f. Causality & Kramers-Kronig relations(4)
   g. Light scattering(2)

3. Special Topics on Ultrafast Optics (6)
   a. Representation of short optical pulses (2)

b. Pulse propogation (4)

4. Geometrical Optics (8)
   a. Waves and rays in inhomogeneous (gradient index) media (2)
   b. Fermat's Principle (2)
   c. Gradient-index lenses and fibers (2)
   d. Lenses and image formation (1)
   e. ABCD matrices (1)
      (i) of optical elements
      (ii) of imaging systems
      (iii) of quadratic ducts (fibers & grin lenses)
   f. Aberrations (2)

5. Interference (6)
   a. Addition of waves (1)
   b. Young's interference (1)
   c. Michelson interferometer(1)
   d. Dielectric layer (1)
   e. Fabry-Perot interferometer (1)
   f. Fermat's Principle revisited (1)

6. Diffraction and Beam Propagation (10)
   a. Huygens' Principle (1)
   b. Gaussian beams (2)
      (i) Paraxial wave equation & Hermite-Gaussian solution
      (ii) Properties of Gaussian beams
      (iii) ABCD matrices and Gaussian beams
   c. Fresnel-Kirchoff formulation & obliquity factor (1)
   d. Fraunhofer diffraction (2)
      (i) Rectangular & circular apertures
      (ii) Arrays of apertures & diffraction gratings
      (iii) Fourier transformation by a lens
   e. Fresnel diffraction (2)
      (i) Fresnel integral & Cornu spiral
      (ii) Fresnel zones
   f. Image formation and resolution (2)

7. Coherence (4)
   a. Fringe contrast and temporal coherence (2)
   b. Spatial coherence(2)