Course: P19 (Modern Physics) Fall Quarter 2005

Lecturer: Miles Blencowe
Office: Rm. 248 Wilder
Ext: 6-2969
Office Hours: Thursdays: 9-11 AM (or by appointment)

Time & Place:
Monday, Wednesday & Friday 8:45–9:50AM in Wilder 102.
X-hour: Thursday 9-10 AM in Wilder 102 (used only to make up possible cancelled lectures).

Lab Schedule:
Session times to be announced.
Dates: Week of October 3 (Interference), October 10 (Photoelectric effect), November 1 (e/m), November 7 (Hydrogen spectrum).

Exam Schedule:
Midterm: October 25 (Tuesday) 7 PM.
Final: December 6 (Tuesday) 3 PM.

Syllabus:

1. *Waves in general* [Ohanian Vol. 1, Ch.16, Sec. 16.1-2 (pages 412-418), Sec. 16.5-6 (pages 423-431)]: Wavelength, frequency and velocity. Superposition principle: traveling waves, standing waves and beats.

2. *Electromagnetic waves* [Ohanian Vol. 1, Ch. 16, Sec. 16.4 (pages 421-2); Ohanian Vol. 2, Ch. 39, Sec. 39.4 (pages 954-958), Ch. 40, Sec. 40.1 (pages 971-976), Ch. 36, Sec. 36.1-4 (pages 873-881, 883-885), Ch. 37, Sec. 37.4 (pages 910-915); Beiser Ch. 2, Sec. 2.3-4 (pages 62-68)]: Interference: two-slit and multiple-slit.
   Lab 1: Interference and polarization of light
   Diffraction. Polarization, Malus' Law, birefringence. Energy of mechanical and electromagnetic waves. Photoelectric effect and introduction to the photon concept.
   Lab 2: The photoelectric effect

3. *Special relativity* [Beiser Ch. 1, Sec. 1.1-5 (pages 1-19), Sec. 1.7-10 (pages 22-36); Beiser Ch. 2, Sec. 2.9 (pages 85-89)]: Principles of special relativity; the Michelson-Morley experiment. Time dilation, length contraction, lack of simultaneity. Relativistic Doppler shift, addition of velocities. Energy and momentum, relativistic mass. The meaning of $E = mc^2$ (nuclear masses and pair annihilation). Effects of gravity on photons (gravitational bending and redshift).

4. *Photon –matter interactions* [Beiser Ch. 2, Sec. 2.4-8 (pages 68-85)]: X-ray diffraction, Compton scattering (as wave/particle properties). Pair-production and pair annihilation.

5. *Particle nature of matter* [Serway Ch. 3]: Motion of electrons in $\vec{E}$ and $\vec{B}$ fields, Thompson measurement of (e/m).
   Lab 3: Measurement of e/m of the electron

6. *Wave nature of matter I* [Beiser Ch. 3, Sec. 3.1-3 (pages 93-9), Sec. 3.5-6 (pages 104-8); Ch. 4, Sec. 4.2-5 (pages 124-138)]: DeBroglie relation and matter waves. Diffraction from crystals. Quantization of energy for particle in box. Bohr model of the hydrogen atom.
   Lab 4: The spectrum of hydrogen

7. *Wave nature of matter II* [Beiser Ch. 5, Sec. 5.1-8 (pages 161-183)]: Schrödinger equation; energy and momentum operators. Meaning of the wave function; probability densities and mean values. Relation of the time-dependent and time-independent Schrödinger equations. Bound states (the infinite square well). Heisenberg uncertainty principle.

Course Requirements:

1. Problem sets (roughly eight in total) [50%].
   Posted Fridays. Put in P19 homework box (outside my office) by 6PM following Friday.
2. Labs (four in total) [25%]
3. Midterm [10%].
4. Final [15%].

Most materials, including problem sets and solutions will be posted on Blackboard.

Recommended text: Arthur Beiser, "Concepts of Modern Physics 6th Ed".

Kresge Reserve (4 Hour Loan):

Ohanian, 6 copies; Serway, 2 copies.