# **Physics 200C Final Exam 10-June-09**

**Dr. Cebra Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Instructions: Work all parts of each problem (each problem worth 50 points). No notes, calculators, etc. Please write your name on every page – they will be separated. Staple additional sheet to their respective problems.

1. Consider a light wave with *p*-polarization incident on a polished aluminum surface. The real part of the index of refraction is *n*, while the imaginary part is *k*.

1. Determine the reflection coefficient, *Rp*, as a function of incident angle.
2. Draw a plot of *Rp* as a function of incident angle *i*.
3. Find the value of incident angle *i* for which *Rp* is a minimum.

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2. For a plane wave, , incident on an aperture with the aperture function *f0*(***r***), where *f0* = 1 within the aperture and *f0* = 0 otherwise, the diffracted amplitude in the Fraunhofer approximation is



Where ***k*** = ***k*** – ***k0*** and ***k*** = *k****r***

1. Show that if the screen includes two identical apertures separated by ***r***, then the diffracted *intensity* is



1. Consider the case when each aperture is circular with a diameter *d*, the separation between the aperture is *r* = 3*d*, and the wavelength on the incident light is  = 9*d*. Sketch the pattern that would be observed on a distant screen.

Remember: 



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3. Radiation from moving electrons:

a) The classical model of a hydrogen-like atom has a single electron in rotating in a circular orbit of radius *r* around a point-like nucleus of charge *Z*e. Calculate the fractional energy radiated per revolution, *PT/Ek*, where *P* is the radiated power, *T* is the orbital period, and *Ek* is the kinetic energy of the electron.

b) The Large Electron-Positron Collider (LEP) accelerated electrons to an energy *E* >> *m*e and maintained them in circular orbits or radius *R*. Determine the fractional energy radiated per revolution at LEP.

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4. The scalar and vector potentials of an oscillating dipole with dipole moment ***p****0* and frequency ** are respectively:



a) Show that these potentials are in the Lorentz gauge.

b) Find the electric and magnetic fields and the Poynting vector.

c) Find the total power radiated.

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5. A magnetic monopole with magnetic charge *qm* passes through matter and losses energy by collisions with electrons, just as does a particle with electric charge *zqe*. For the charged particle the determination of the energy loss includes the following steps:



1. Show that the energy loss per unit distance for a monopole is given approximately by:



1. Sketch the d*W*/d*s* curve for a monopole and for a charged particle of similar mass. Discuss the similarities and the differences.
2. With the Dirac quantization condition determining the magnetic charge, what *z* value is necessary for an ordinary charged particle in order that it lose energy at relativistic speeds at the same rate as a monopole? [Hint, recall that the fine structure constant ]