Electrodynamics III: Assignment 2.
Due April 19 at 11:00am in class or 10:45am in the instructor's mailbox.

1. Show Arago and Fresnels' 1816 interference result: Two beams polarized at right angles to each other cannot interfere.

2. Consider the scalar-diffraction formalism applied to plane waves incident normally on a circular aperture in a perfectly-absorbing screen. Show that along the axis in the limit where the size of the aperture is infinite, the result for the diffraction is sensible, that is there is no scattered wave and there's a plane wave at observation points along the axis. Also justify the leading factor of ik/2π in the Kirchhoff integral. This is a bothersome result in that, with a hole of infinite diameter, the observer is always in the Fresnel region where the Fraunhhoffer approximations break down. Yet the result is correct.

3. Find the on-axis intensity in the Fraunhhoffer region due to plane waves normally incident on an opaque circular disk. This is a hard problem ab initio, but relatively easy using previous problem for the screen with hole plus Babinet's principle of complementary screens. This demonstrates "Poisson's spot".

4. Consider plane waves incident normally on an aperture consisting of a long slit of width D and length L (L>>D) in a perfectly-absorbing screen. In the Fraunhhoffer region, show that the scalar-diffraction model yields the single-slit diffraction result from first-year physics $I = I_0 \left(\frac{\sin\beta}{\beta}\right)^2$, where beta is an effective angle. (Working in the Fraunhhoffer region may simplify the Green's-function integration.)

[ver 10apr19 12:45]