3. **Kirchoff’s Approximation for Complementary Scatterers** A monochromatic plane wave polarized along the $y$-axis is normally incident from $z < 0$ onto a two-dimensional conducting scatterer confined to the $z = 0$ plane. Use Kirchoff’s approximation but do not use the Fraunhofer approximation.

(a) Let the scatterer be a conducting disk of radius $a$. Find $E_{\text{disk}}(0,0,z > 0)$

(b) Let the scatterer be an infinite conducting sheet with a circular aperture of radius $a$ centered on the $z$-axis. Find $E_{\text{ap}}(0,0,z > 0)$.

(c) Confirm that

$$E_{\text{ap}} = E_{\text{inc}} - E_{\text{disk}}$$

. Explain why Babinet’s principle is not the reason for this.