**Qualifying Exam 2013**
**EM, Shanhui Fan**

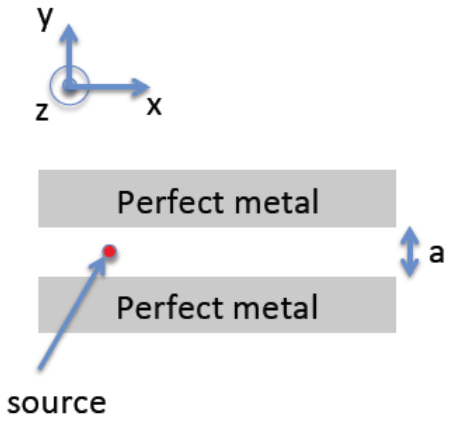


Figure 1

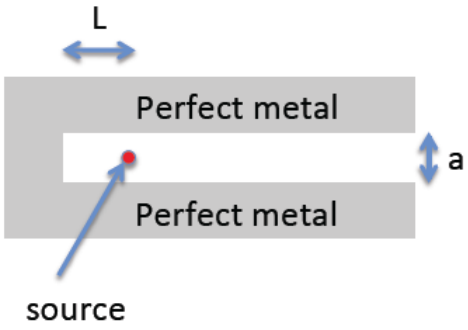


Figure 2

Consider a parallel-plate waveguide, with PEC (perfect electric conductor) sidewalls and air in between. The width of the waveguide is *a*. We consider two-dimensional system. (i.e. the fields and the structures are uniform in the *z*-direction).

(1) Sketch the ω-k relation for the lowest-order TE mode (with E-field polarized along the z-direction), and for the lowest-order TM mode (with E-field polarized along the y-direction).

(2) Suppose we put in an oscillating line source as indicated in Figure 1. The source oscillates at a frequency $\omega_0$. How does the power radiated into the waveguide changes as a function of $\omega_0$? Consider both cases, the TE case with the line source polarized along the z-direction, and the TM case with the line source polarized along the y-direction.

(3) Suppose we truncate the waveguide with a perfect electric conductor at the end as shown in Figure 2. For the TM case, suppose we choose $\omega_0 = 0.1\dfrac{2\pi c}{a}$, how does the power radiated into the waveguide vary as a function of the distance *L* between the source and the truncation?