Shanhui Fan

In this exam, the metal is all assumed to be perfect metal. (i.e. perfect electrical conductor).

(a) What are the boundary conditions for the electric fields at the metal-air interfaces?
(b) What are the boundary conditions for the magnetic fields at the metal-air interfaces? Why?
(c) Consider an infinitely long cylindrical air hole inside a metal, sketch qualitatively the $\omega \sim \beta$ diagram for the lowest order propagating modes inside the hole, where ω is the angular frequency for the waves and β is the propagation constant. (i.e. the field varies along the z-direction, defined as the axis of the cylinder, as $e^{-i\beta z}$.)
(d) Sketch the electric field vector distribution of the lowest order propagating inside the hole.
(e) Consider the following experiment, where a plane wave is incident upon a metal film with a hole introduced in it. Could you sketch the amount of transmitted power as the wavelength is varied from $\lambda >> a$ to $\lambda \sim a$, where a is the radius of the hole?