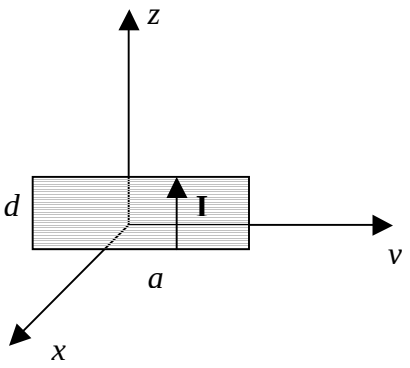
EE151 Homework 7

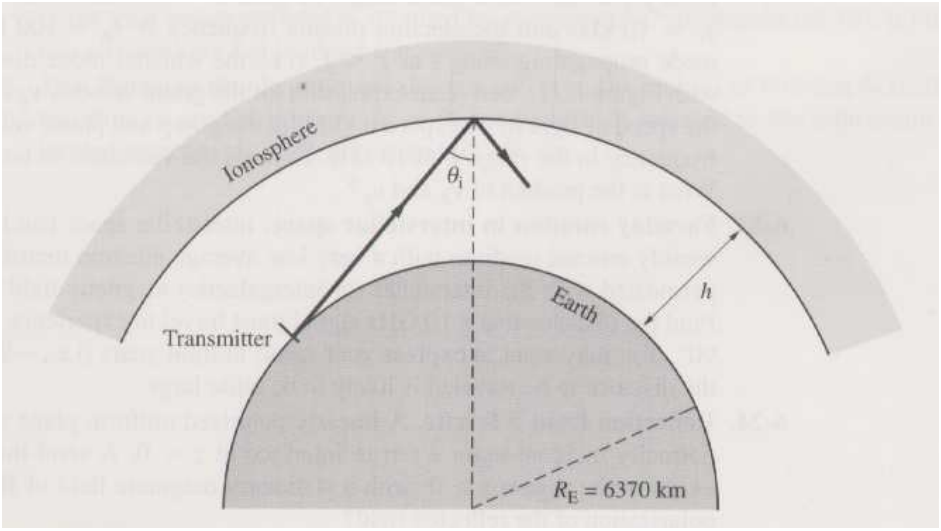
1. Problem 14.25, Hayt and Buck.

2. Antenna. Consider a current sheet (of sides *a* and *d*) centered at the origin, with current flowing in the z-direction as the source of radiation. Assume *d* is small compared to the wavelength, the current sheet has infinitesimal thickness and also assume a uniform current $I = I_0 \cos(\omega t)$. (Note: This is similar to the dipole antenna in the book, but now we consider a 2D source, as opposed to a 1D dipole)
a) Calculate the vector potential **A**.
b) Calculate the electric and magnetic fields in the far field and the power radiated.



3. Plasma filled waveguide. Consider a rectangular waveguide of dimensions *a, b* filled with an isotropic plasma with plasma frequency ω_p . Find the cutoff frequency for the dominant TE_{10} mode in terms of *a, b* and ω_p . Are there any special conditions on *a, b,* ω_p for TE_{10} to propagate?

4. Ionosphere. Consider the propagation of waves by reflection from the ionosphere as shown in the figure below.
a) On a particular date and time of day, and above a particular geographic location, the highest electron density occurs at an altitude of ~400km, and the plasma frequency at this altitude is f_p=5MHz. Neglecting the ionization below this densest layer (i.e., assume electron density to be zero below 400km altitude), determine the greatest possible angle of incidence θ_I at which an electromagnetic wave originating at a ground-based transmitter could possibly strike the layer.
b) How far away from the transmitter will the reflected radiation return to earth?
c) What is the highest frequency at which this obliquely incident radiation will be totally reflected?


Ionosphere
θ_i
Earth
h
Transmitter
$R_E = 6370$ km