Physics 606: Homework #6

Due April 25, 2017

Jackson: Problems 7.19b, 7.22, 7.26, 7.28, 8.2, 8.4 not graded

1) Plane waves propagate in a gyro-tropic medium, i.e. one that has a dielectric tensor in the form:

\[
\begin{bmatrix}
\epsilon_\perp & i\epsilon_x & 0 \\
-i\epsilon_x & \epsilon_\perp & 0 \\
0 & 0 & \epsilon_\parallel
\end{bmatrix}
\]

where all the \(\epsilon\)'s are real. For the special case of propagation in the “\(\parallel\)" (that is in the \(z\)) direction derive a dispersion relation for the different polarizations of em waves. Suppose a wave is linearly polarized at \(z=0\). Show that if a wave is linearly polarized at \(z=0\), it will be linearly polarized for all \(z\), but with a polarization direction that varies with \(z\). Obtain an expression for the rate of variation.

2) A TM\(_{21}\) mode propagates down a rectangular wave guide with dimensions \(a = 0.04\) m. and \(b = 0.03\) m., and \(\mu = \mu_0\). For \(z<0\) the wave guide is evacuated, and for \(z>0\) the waveguide is filled with dielectric with \(\epsilon = 2\epsilon_0\).

![Waveguide Diagram](image)

a. In what frequency range will the mode propagate in each section of the wave guide?

b. Calculate the frequency for which a wave incident from \(z=-\infty\) will be totally transmitted to \(z=\infty\), independent of the value of \(L\)