Problem 1: Two long coaxial cables are joined at one point. Let the wave velocity and characteristic impedance for coax #1 be \( v_1 \) and \( R_{c1} \) and for coax #2, \( v_2 \) and \( R_{c2} \). Assume a voltage wave \( f(x - v_1 t) \) is moving down coax #1, heading toward the junction with coax #2.

a) What is the current wave accompanying the voltage wave \( f(x - v_1 t) \)?
b) Find the reflected and transmitted voltage and current waves.
c) Find the amplitude of the reflected voltage wave, relative to the incident, for the specific case of \( R_{c1} = 50 \Omega \), \( R_{c2} = 75 \Omega \).

Problem 2: A linearly polarized plane electromagnetic wave of frequency \( \omega \), propagating in vacuum along the \( z \)-axis with an electric field of amplitude \( E_0 \) polarized along the \( x \)-axis, is normally incident upon a very thin metal sheet. The metal sheet lies in the \( x - y \) plane. Assume that the penetration depth \( \delta \) at the frequency \( \omega \) is much greater than the sheet thickness \( t \).

For parts a), b), and c) assume that the metal sheet has an ordinary ohmic conductivity \( \sigma \).

a) Find the reflected and transmitted electromagnetic waves (both the electric and magnetic fields). You may assume that the sheet is essentially infinitely thin, but that the product \( \sigma t \) is non-zero.
b) Find the fraction of the incoming energy flux which is reflected, transmitted, and absorbed by the metal sheet.
c) Determine what conditions (on \( \sigma \) and \( t \)) will maximize the energy absorption. What is the maximum energy absorption fraction?

Now we will assume that the conductivity of this particular metal is somewhat unusual. We shall replace the usual relation between current density and electric field, \( \vec{j} = \sigma \vec{E} \) with the following:

\[
K_x = \sigma_H E_y \\
K_y = -\sigma_H E_x
\]

In other words, the sheet current density \( \vec{K} \) in the thin metal plate is related to the electric field \( \vec{E} \) via a new conductivity coefficient, \( \sigma_H \). Note that the \( x \)-component of the current density is determined by the \( y \)-component of the electric field, and the \( y \)-component of the current density by the \( x \)-component of the electric field. Note also the minus sign. While this situation may seem peculiar to you, it is in fact readily encountered when certain metals are subjected to intense static magnetic fields. Do not worry about how this situation comes about; just assume it is true.

d) Once again, find the reflected and transmitted electromagnetic waves. Be careful about what you assume concerning the polarization of the outgoing waves. (The incident wave is linearly polarized as before.)
e) What fraction of the incoming power is absorbed?
f) Describe, quantitatively, the polarization state of the transmitted beam.