

Physics 106c: Electrodynamics

Problem Set 5

Due: 4pm Friday, May 8, 2009

Remember: Late homework will be granted 50% credit up to one week late, unless you have a note from the Dean or a health official.

Reading: Griffiths Chapter 9.

Problems:

1. A transmission line can be created using two parallel conducting strips. Assume that the width of each strip is W , the separation of the strips is $d \ll W$, and that each strip is “infinitely thin”. Assume one strip is a perfect conductor but that the other strip is such that at the desired frequency of operation its conductivity is dominated by the kinetic inductance of its electrons. (You may take the density of carriers in this strip to be n and their mass to be m .) Derive the appropriate wave equation for this transmission line. Determine under what conditions the ordinary magnetic inductance is unimportant and, in this regime, what the characteristic impedance of the line is.

2. A 3D “rectangular” microwave resonator has inner dimensions $a = 1$ cm, $b = 0.5$ cm, and $c = 0.5$ cm. Find the spectrum of TE modes. Using the approximate methods discussed in class, determine the Q-factor of the lowest TE mode. (The Q-factor is defined to be 2π times the time average energy stored in a mode divided by the amount of energy lost in one full cycle of the mode.) Assume the resonator is made of copper, with conductivity 6×10^7 ohm⁻¹ m⁻¹.